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Training Technologies Pilot Study: Cost Comparison Analysis

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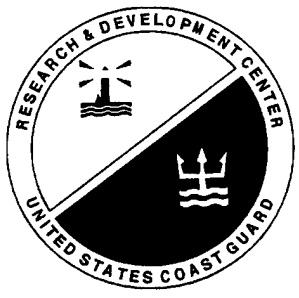

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16. Abstract (200 words or less)

A pilot study was performed by the United States Coast Guard's Research and Development Center to explore the potential benefits of using state-of-the-industry technologies as a "travel-free" alternative to instructor-led training performed at resident training centers (i.e., schoolhouse environment). This report presents the results of the cost comparison analysis that was performed as part of the pilot study. An effectiveness evaluation and a duty station implementation analysis were also performed as part of the pilot study. The results of those two efforts are presented in a separate report.

The cost comparison analysis compared the costs of operating an instructor-led resident course that is delivered to students at a resident training center, to the costs of operating an equivalent, nonresident computer-based version of the same course, that is delivered to students at their duty stations. Two scenarios were considered in performing the analysis; the conversion of a single resident course to nonresident computer-based training, and the conversion of a "meaningful" number of resident courses. "Meaningful" is defined as the number of resident course conversions necessary to result in a savings of training center operations and personnel costs. Capital Expenditure Analysis Methodology (e.g., Pay-back Period) was applied in performing the comparisons.

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METRIC CONVERSION FACTORS

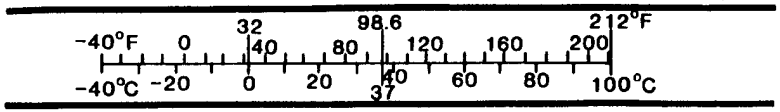
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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LIST OF ABBREVIATIONS AND TERMS

AN/WSC-3 - This designates the AN/WSC-3(v)7 UHF Transceiver Maintenance Course. Some United States Coast Guard training references refer to this course as COM-01. The resident version of this course is held at the United States Coast Guard Training Center in Petaluma, California.

Annual Cost Avoidance (Savings) - This value represents the difference between Total Annual Costs to operate an instructor-led course at a resident training center, and the Total Annual Costs to operate an equivalent, nonresident computer-based version of the course at duty stations. Total Annual Costs are calculated as Operations & Maintenance Costs plus Annual Student Costs for a given year of operating a course.

Annual Student Costs - The sum of all Per Student Costs associated with students attending a course, or group of courses, in a single year. In this report, this value is calculated as Annual Student Throughput Rate, multiplied by Per Student Costs.

Annual Student Throughput Rate - The number of students attending a course, or training program, each year. The value for Annual Student Throughput Rate may be based on historical information, or based on projections of future throughput.

CBT - Computer-based training.

CGA - United States Coast Guard Academy, New London, Connecticut.

Course Life-span - The useful life of the training course to the United States Coast Guard. The useful life of the course would be closely tied to the useful life of the system, or equipment being trained, to the United States Coast Guard. Over the useful life of a course (Course Life-span), a course will undergo periodic revisions to materials and course content. Costs for those revisions are accounted for in the Cost Model through the consideration of the nonresident computer-based training Courseware Maintenance cost factor.

FBI - Federal Bureau of Investigation.

G-CFS - United States Coast Guard Headquarters Office of Financial Systems, Washington, D.C.

G-SRF - United States Coast Guard Headquarters Office of Force Managers, Washington, D.C.

G-WTT - United States Coast Guard Headquarters Office of Training and Performance Consulting, Washington, D.C.

ILRES - Instructor-led training, delivered to students at a resident training center (schoolhouse environment).

Interactive Video-Teletraining - Interactive video-teletraining (IVT) covers several delivery options involving the transmission of voice and images over land-lines or satellite systems.

Investment Costs - Non-recurring costs associated with the creation of a course, and preparations for the implementation of the course. For a nonresident computer-based course, these costs would include computer-based training design and development, United States Coast Guard subject matter expert support for the design and development efforts, and the initial purchase cost of equipment (e.g., laptop computers) used to deliver the nonresident computer-based training course to students at their duty stations.

ISD Process - Instruction Systems Design Process.

Margin-for-Error - Investment decisions are based on estimates of events in the future, such as operations costs and student throughput rates. Margin-for-error is the difference between some minimum point an organization is willing to accept as a return for the investment, and the estimated benefit that will be received from the investment. If the difference is greater than zero, then the risk of under-estimation of future events is diminished by the amount of that difference. The minimum return an organization is willing to accept may be avoiding a negative value for Total Savings, or some Rate-of-Return based on the cost of borrowing money to finance the investment, a profit margin, or some other measure important to the organization.

"Meaningful" Number of Courses - For purposes of this cost comparison analysis, the concept of "meaningful" means the number of courses which would need to be converted in order to result in a savings of training center operations and personnel costs. The exact number of courses that would be represented by the word "meaningful" needs to be determined in a follow-up analysis.

M&IE - Meals & Incidental Expenses.

NAWC - Naval Air Warfare Center, Orlando, Florida

Net Present Value of Total Savings - The estimated worth of savings spread out over a period of several years in today's dollars, minus investment (startup) costs in the nonresident version of a course. Savings is the difference between the Total Annual Costs of operating the instructor-led, resident course, and the Total Annual Costs of operating an equivalent, nonresident, computer-based training version of the same course. Investment (startup) costs would include the cost to design and develop computer-based courseware, the cost of US Coast Guard subject matter expert support, and the cost of computer equipment used to deliver the course to students at their duty station.

Nonresident - Training delivered to students at their duty stations via some type of media mix (e.g. computer-based training, embedded training, correspondence).

Nonresident CBT - Training delivered to students at their duty stations, via computer-based training (CBT). An acronym, "NRCBT", is used in this report.

NPV - Net Present Value. See "Net Present Value of Total Savings".

NRCBT - Nonresident computer-based training, delivered to students at their duty stations.

NRCBT Annual Savings - This value represents the difference between Total Annual Costs to operate an instructor-led resident course, and the Total Annual Costs to operate an equivalent, NRCBT version of the course. Total Annual Costs are calculated as Operations & Maintenance Costs plus Annual Student Costs for a given year of operating a course.

Operations & Maintenance Costs - Recurring costs which are incurred on a yearly basis. For the instructor-led resident course, this would include the cost of operating and staffing a training center each year, and the cost of any additional instructors not accounted for in the staffing costs, but are required as the result of increased student throughput. An acronym, "O&M Costs", is used in this report to represent the term Operations & Maintenance Costs.

Pay-back Period – A duration in years when the total costs for operating the instructor-led, resident version of a course, and the total costs for operating a nonresident version of the same course, are equivalent (e.g., ILRES costs = NRCBT costs). This data point is calculated by first summing the startup (initial) costs for the nonresident version of the course, based on a given level of annual student throughput, and then dividing that result by the annual savings which can be contributed toward the debt (investment). In the case of the WSC-3 UHF Transceiver Maintenance Course which was converted to a nonresident CBT course, the investment cost includes the number of laptop computers and shipping cases that would be needed for a given level of annual student throughput.

Per Student Costs - Recurring costs which are associated with a student participating in a training activity (program). Per Student Costs, when multiplied by the Annual Student Throughput Rate, results in the Annual Student Costs incurred each year, as the result of operating a particular version of the course. For the instructor-led resident course, this would include the cost of student time to complete the course, costs associated with transporting the student between the student's duty station and the training center, and Per Diem costs.

Rate-of-Return - The term, Rate-of-Return, is used in two contexts in this report. When referring to Rate-of-Return as a Capital Expenditure Analysis data point, Rate-of-Return is defined as the percentage of the investment costs in the nonresident version of the course, which are recovered in the first year of operating the nonresident version of the course.

The term is also used in this report to denote the return on investment (Rate-of-Return) desired by an investor over the life of the investment. In the case of this cost comparison analysis, life of the investment is called Course Life-span.

Resident - Instructor-led training which takes place at a training center (schoolhouse). An acronym, "ILRES", is used for "resident" in this report.

RTC Yorktown - United States Coast Guard Reserve Training Center, Yorktown, Virginia. RTC Yorktown has been designated by the Coast Guard as the Center of Excellence for nonresident training, which includes computer-based training.

R&DC - United States Coast Guard Research and Development Center, Groton, Connecticut.

SME - Subject Matter Expert(s).

SPC Model - Standard Personnel Costs Model.

Sunk Costs - Costs that are not affected by a manager's decision between two or more alternatives, are considered sunk costs. Deciding whether or not a cost should be treated as a sunk cost in a Cost Analysis, is dependent on the particular situation being addressed by management. For example, the construction or purchase price of a building owned by the USCG would be considered a sunk cost unless there were an opportunity, for example, to recover that cost through sale of the building.

System (Equipment) Life - The useful life of a system or piece of equipment to the USCG. The life-span of a course would not exceed the useful life of a system to the USCG.

Total Annual Costs - The sum of Operations & Maintenance Costs (O&M Costs), and Annual Student Costs, as the result of operating a course, or set of courses, in a given year.

$$\text{Total Annual Costs} = \text{O\&M Costs} + \text{Annual Student Costs}$$

Total Savings - The difference between the cost of creating and operating the instructor-led version of a course, which will be delivered to students at a resident training center, and the cost of creating and operating an equivalent, nonresident CBT version of the same course, delivered to students at their duty stations. If the calculated value for Total Savings is positive, then the investment in the nonresident CBT version of the course would be supported by the cost comparison analysis.

TRACEN Petaluma - United States Coast Guard Training Center, Petaluma, California.

USCG - United States Coast Guard.

EXECUTIVE SUMMARY

The United States Coast Guard (USCG) Research and Development Center (R&DC) was tasked by the USCG Headquarters Office of Training and Performance Consulting (G-WTT) to explore the potential benefits of using state-of-the-industry technologies as "travel-free" alternatives to instructor-led resident training, provided at a training center (schoolhouse environment). Teaming with the USCG Training Center in Petaluma, California (TRACEN Petaluma), and with the assistance of USCG Headquarters Office of Force Managers (G-SRF), a pilot study was launched. For the pilot study, a one-week (40-hour) instructor-led resident course was converted to an equivalent, nonresident computer-based training (CBT) version, for delivery to students at their duty stations. The course selected, AN/WSC-3(v)7 UHF Transceiver Maintenance Course (AN/WSC-3), is considered a good course within the USCG and had an anticipated student throughput in Fiscal Year 1997 (FY97) of 72 students.

An evaluation of the CBT AN/WSC-3 course was performed. The evaluation consisted of an effectiveness evaluation, a duty station implementation analysis, and a cost comparison analysis. Results of the effectiveness evaluation show that quality nonresident CBT delivered to students at their duty stations (NRCBT) is equivalent in effectiveness to instructor-led training given at a resident training center (ILRES). However, the duty station implementation analysis identified issues that need to be addressed to ensure that the USCG realizes the full potential of NRCBT. Many of those issues were related to the infrastructure required to support NRCBT, such as student technical support (i.e., Help Desk) and course delivery hardware. The detailed results of the effectiveness evaluation, and the duty station implementation analysis efforts are presented in a separate report, "Training Technologies Pilot Study: Nonresident Computer Based Training Effectiveness Evaluation."

The cost comparison analysis, which is the subject of this report, used the cost data generated by the pilot study to develop cost values for NRCBT. These included the cost of designing and developing interactive CBT courseware, the cost of equipment to distribute the NRCBT, and shipping costs for the NRCBT course materials. For the ILRES side of the cost comparison analysis, costs related to the operation of the ILRES version of the AN/WSC-3 course at TRACEN Petaluma were used. These costs included the cost of student time to complete the course (40 hours), and the costs of student transportation to/from the resident training center. Although data obtained from TRACEN Petaluma was used in performing this cost comparison effort, the results can be used more generally across USCG training centers.

A list of cost factors considered is presented in Table ES-1. Investment Costs are non-recurring costs associated with the creation of a course and preparations for its implementation. Operations &Maintenance (O&M) Costs are recurring costs, which are incurred on a yearly basis (e.g., Training Center Operations & Personnel). Per Student Costs are recurring costs that are associated with student participation in a training activity (e.g., Student Transportation).

Table ES-1 Cost Factors Considered in Cost Comparison Analysis

COST CATEGORY	NONRESIDENT CBT COURSE	INSTRUCTOR-LED RESIDENT COURSE
Investment	CBT Design & Development USCG SME Support Equipment for Course Distribution	Classroom & Lab Space Classroom & Lab Equipment
Operations & Maintenance	Distribution Center Operations & Personnel Student Support (e.g., Help Desk) Courseware Maintenance	Training Center Operations & Personnel
Per Student	Student Time Duty Station Facilitator Time Shipping Of Course Material Student Materials	Student Time Student Transportation Per Diem Student Materials

To perform the analysis, a Cost Model was developed using Microsoft Excel® software.

The Cost Model applies the Capital Expenditure Analysis methodology. This methodology is an accepted, and widely used method. It provides information that a decision-maker would use to determine whether or not to make an investment. For this cost comparison analysis, the investment decision is between staying with an existing ILRES course, or developing and implementing an equivalent, NRCBT version of that course. The analysis concentrated on two Capital Expenditure Analysis data points, Pay-back Period (break-even point in years) and Total Savings over the life-span of a given course.

Two scenarios were considered for cost comparison. Scenario One involves the replacement of a single existing ILRES with an equivalent, NRCBT version of the same course. This kind of replacement will have little impact on a training center's operation and personnel budget requirements. Elimination of resident costs (cost avoidance), as a result of replacing the ILRES course would be limited to Per Student Costs (i.e., Student Time, Student Materials, Student Transportation, and Per Diem).

Scenario Two is the replacement of a "meaningful" number of existing ILRES courses with NRCBT versions of those courses. This allows re-organization of the USCG training structure to save approximately the proportion of training center costs shared by each course conversion. As a result, all costs associated with the cost of operating and staffing a training center are considered.

An Annual Student Throughput Rate of 72 students and a Course Life-span of seven years was used in the Cost Model runs for both scenarios. Costs associated with course revisions over the life of a course are accounted for through inclusion of the Courseware Maintenance cost factor.

The analysis, presented in Table ES-2, shows that Pay-back Period and Total Savings support investment in the NRCBT version of the course in both scenarios. However, the optimal choice is Scenario Two, as Pay-back Period is decreased by 65 percent, and Total Savings is eight times as great as Total Savings calculated for Scenario One.

Table ES-2 Results of Cost Comparison for Scenarios One and Two

SCENARIO	PAY-BACK PERIOD (In Years)	TOTAL SAVINGS OVER 7 YEARS
One	5.31	$ 84,712
Two	1.85	$ 742,347

In performing a demonstration of extrapolating the results of this cost comparison analysis to the conversion of multiple ILRES courses in the USCG, twenty-two (22) courses were randomly selected across the USCG training program. At one hundred (100) percent consideration of costs related to the operation and staffing of a training center, the combined annual Total Savings for the 22 courses would approach $4.7M. At fifty (50) percent of training center costs, the combined annual Total Savings would approach $1.3M.

A sensitivity analysis was performed to explore the sensitivity of Pay-back Period and Total Savings, to value changes in selected factors used in the cost comparison analysis. The sensitivity analysis revealed that Total Savings is very sensitive to changes in Annual Student Throughput Rates for both scenarios.

This cost analysis is considered a beginning. It demonstrates that the replacement of existing ILRES courses, with an equivalent NRCBT version, has the potential to save substantial training dollars. The optimal scenario is the replacement of a "meaningful" number of courses that allows for the consideration of costs associated with the operation and staffing of a training center. The next steps should be:

1. Perform an in-depth analysis to identify existing ILRES courses appropriate for conversion, and determine the media mix required (e.g., CBT, IVT, correspondence).
2. Determine which of the ILRES cost factors will be impacted and how much can be saved. In parallel, determine the make-up and cost of an infrastructure required to support the successful implementation of nonresident training at USCG duty stations.
3. Perform a cost analysis, based on the estimated total savings from the conversion of the ILRES courses, and the cost of the required infrastructure, to determine how much, if any, savings will be realized by the USCG.

1 INTRODUCTION

1.1 PROBLEM

In an atmosphere of ever increasing budgetary constraints, the U.S. Coast Guard (USCG) needs to find more efficient ways to perform its missions, while maintaining or increasing performance effectiveness. In addition, the USCG needs to make training more responsive to operational unit requirements and schedules.

1.2 BACKGROUND

Technology has demonstrated in both the private sector and other federal agencies, that when applied under the appropriate conditions, it can cut costs while maintaining or increasing effectiveness. One area where technology has been applied successfully, is in the world of training. Technology, such as computer-based training (CBT), has the advantage of providing students with training on-demand, at the student's own pace, and most important, without the student having to travel to a distant training site.

The USCG Research and Development Center (R&DC), under the sponsorship of the USCG Headquarters' Office of Training and Performance Consulting (G-WTT), and with the support of the USCG Headquarters Office of Force Management (G-SRF), has performed a pilot study exploring the potential benefits of using state-of-the-industry technologies as a "travel-free" alternative to instructor-led training provided at training centers (schoolhouses).

The pilot study consisted of two phases. The first phase was the conversion of an existing, instructor-led resident course (ILRES), which convenes at a USCG training center, to a nonresident course delivered to students at their duty stations. Phase one included selection of a course to be converted, selection of the appropriate media mix for delivery of the nonresident version of the course to students at their duty stations, and then performing the conversion. The second phase was to perform an evaluation to determine the cost effectiveness of nonresident training, delivered to students at their duty stations, in comparison to instructor-led, resident training, delivered at training centers. The converted course served to generate data for a cost and effectiveness comparison of nonresident technology-based training and instructor-led, resident-based training. It also provides an applied demonstration of alternative training technology within the USCG.

1.2.1 PHASE ONE – CBT COURSE DEVELOPMENT

The AN/WSC-3(v)7 UHF Transceiver Maintenance Course (COM-01) was selected for conversion. The instructor-led resident course convenes at the USCG Training Center (TRACEN Petaluma) in Petaluma, California. The AN/WSC-3 course is a one-week (40 hour) course with a current annual throughput of 72 students. It was determined by the Project Team that the ideal media for delivery of the nonresident version of the AN/WSC-3 course to students at their duty stations was CBT, which would be developed as interactive courseware (ICW). The course was converted to CBT by an R&DC contractor, Analysis and Technology, Inc., with the

assistance of subject matter experts (SME) supplied by TRACEN Petaluma. Conversion of the AN/WSC-3 course was completed in nine months.

The CBT version of the AN/WSC-3 course consists of two parts, computer-based and hands-on training. The computer-based interactive portion of the CBT course directs the student in a logical progression through each instruction topic and set of problems. Once a student has completed an instruction topic, the student can review the topic on-demand. The self-paced portion of the course requires between six and fourteen hours for completion.

The computer-based section of the course is divided into seven individual modules. The first five modules contain instruction on the maintenance and troubleshooting of AN/WSC-3(v)7 UHF transceivers. The sixth module contains a series of troubleshooting practice problems and the seventh module is for testing student troubleshooting performance. In the future, these tests could be used for acquiring a Qualification Code (certification). Training administrators can access data on both student study times and test scores.

The hands-on portion of the nonresident CBT course should be performed at the student's earliest opportunity. Requiring up to two hours to complete, the student would perform tasks, such as, preventive maintenance (PMS) and executing Built-in Test Equipment (BITE) tests on an actual AN/WSC-3(v)7 UHF transceiver.

1.2.2 PHASE TWO – CBT EVALUATION

The evaluation included three areas; effectiveness, an implementation analysis of CBT at duty stations, and a cost comparison analysis. The evaluation was performed as a team effort by R&DC, an R&DC contractor (Paradigm Associates), and TRACEN Petaluma, with the assistance of multiple sources both within and outside the USCG (e.g., National Security Division of the Federal Bureau of Investigation). The results of the effectiveness evaluation and the CBT duty station implementation analysis are discussed and presented in a separate report entitled "Training Technologies Pilot Study: Nonresident Computer Based Training Effectiveness Evaluation (Final Report)" (Hammell & Kingsley, 1998).

1.2.2.1 Effectiveness Evaluation

The effectiveness evaluation consisted of several types of data for comparison across three groups. Paper-and-pencil knowledge tests were used to determine student knowledge levels both before and after taking the AN/WSC-3 course (pre and post knowledge tests). Upon completion of the course, student troubleshooting skills were evaluated using five hands-on troubleshooting problems performed on actual AN/WSC-3(v)7 UHF transceivers (using realistic problems in a near-working environment, not unlike the duty station). TRACEN Petaluma supplied two subject matter experts to serve as evaluators for the hands-on troubleshooting problems. The effectiveness evaluation also included student and facilitator critiques of the course, and a student background questionnaire.

Three groups of students participated in the effectiveness evaluation. The first group took the instructor-led, resident version of the AN/WSC-3 course at TRACEN Petaluma. This group served as the baseline, against which two CBT groups were compared. The students in one of the CBT groups received the CBT version of the course in a controlled classroom environment (no instructor, only a facilitator) at TRACEN Petaluma. The students in the second CBT group received the CBT version of the course at their duty stations. The duty station group was given two weeks to complete the course, and upon completion, the students were sent to TRACEN Petaluma for evaluation.

The effectiveness evaluation results have demonstrated that nonresident CBT training provided at the duty station can be as effective as instructor-led training provided at a resident training center.

1.2.2.2 Implementation Analysis

The Project Team performed a nonresident CBT duty station implementation analysis. The purpose of the implementation analysis was to identify problems associated with nonresident CBT training at the duty station, and recommend solutions (e.g., procedures, infrastructure changes) that are feasible within the USCG organization. The goal of the analysis was to greatly reduce the implementation risks for nonresident CBT courses delivered at duty stations in the future, and was documented as part of the pilot study's evaluation final report. The implementation analysis team, which consisted of R&DC staff and an R&DC contractor (Paradigm Associates), visited selected operational units where personnel took the nonresident CBT course at their duty station (unit). The operational units visited were the CGC Polar Star, CGC Dependable, CGC Cowslip, ESU Honolulu, ESU Portsmouth, ESD Corpus Christi, and the R&DC. In addition, the implementation analysis team visited two U.S. Navy vessels at Norfolk Naval Base (Norfolk, Virginia) to draw upon their experiences with implementing nonresident training in the field. These vessels had space set aside for training. The U.S. Navy vessels visited were the U.S.S. Mount Whitney (Command Vessel) and the U.S.S. Mitscher (Guided Missile Destroyer).

The duty station implementation analysis showed that there is strong support for nonresident training (e.g., CBT, IVT) provided at duty stations. However, the analysis also identified issues which need to be addressed to ensure the successful implementation of nonresident training at duty stations.

1.2.2.3 Cost Comparison Analysis

A cost comparison analysis was performed to determine the cost efficiency of nonresident CBT training delivered to students at the duty stations, in comparison to instructor-led resident training. The objective of this analysis was to explore the cost savings potential of nonresident CBT training. This includes identifying major cost factors that must be considered when making decisions regarding conversion of instructor-led resident courses.

2 COST COMPARISON METHODOLOGY

The cost comparison analysis is an analysis of cost differences between existing, instructor-led resident training, delivered at a resident training center (ILRES), and nonresident CBT training, delivered to students at their duty stations (NRCBT).

Two independent scenarios for replacement of an existing ILRES are considered in this analysis. Scenario One is the replacement of a single existing ILRES with a NRCBT version of the course. Replacement of a single existing ILRES course will have little or no impact on a training center's infrastructure costs, such as, the cost of operations and personnel.

Scenario Two is the replacement of a "meaningful" number of existing ILRES courses with NRCBT training over the USCG training program. Replacing a "meaningful" number of existing ILRES courses would permit restructuring of the USCG training program. The extent to which the USCG training program is restructured would determine which of the existing ILRES costs could be recovered. The USCG in a follow-up analysis must determine the exact number of courses that would define "meaningful". The follow-up analysis would include identifying those existing ILRES courses which would be appropriate for conversion to a NRCBT version of the course and analyzing relative cost data.

Since the AN/WSC-3(v)7 UHF Transceiver Maintenance Course (COM-O1), which resides at TRACEN Petaluma, served as the test case for the Training Technologies Pilot Study, TRACEN Petaluma costs were used for the existing ILRES side of the cost comparison.

It is important to note that the ILRES cost calculations used in the three sets of Cost Model runs are based largely on data obtained from the USCG Training Center (TRACEN Petaluma) in Petaluma, California. The results of this analysis, however, should not be interpreted as applying specifically to TRACEN Petaluma. Rather, the TRACEN Petaluma data was only used in the cost comparison analysis for a more generalized analysis. The TRACEN Petaluma data is accurate only for the single course scenario (Scenario One), since multiple course conversions (Scenario Two) would likely occur across multiple USCG training centers.

2.1 COST MODEL

2.1.1 MODEL DEVELOPMENT

For the cost comparison analysis effort, a Cost Model was developed as a tool to perform the analysis. The Cost Model was developed using the Microsoft Excel ® spreadsheet software. Its development was an iterative process, performed in parallel with data collection and analysis. Developing the Cost Model in this manner, allowed the R&DC analysts to gain a better understanding of the cost issues facing the USCG training community, and served as a tool for communication of ideas between the analysts and potential information sources. At various stages of the models development, the USCG and other organizations (e.g., Naval Air Warfare Center) reviewed the Cost Model. Based on feedback provided from those reviews, the Cost Model was further refined.

The Cost Model applies the Capital Expenditure Analysis methodology (Gray & Ricketts, 1982; Pappas, Brigham, Hirschey, 1983). The Capital Expenditure Analysis methodology is an accepted and widely used method among both the private and public sectors of the United States. A Capital Expenditure Analysis is performed when a managerial decision involves the long term commitment of funds which will result in future benefits to the organization. The Capital Expenditure Analysis is a methodology that includes the calculation of the following data points:

- **Pay-back Period**

  Pay-back Period is a duration in years when the total costs for operating the ILRES version of a course, and the total costs for operating the nonresident (e.g., interactive CBT, embedded training, correspondence) version of the same course, are equivalent. It is calculated by first summing the investment costs (defined in Glossary) for the nonresident version of the course, based on a given level of annual student throughput, and then dividing that result by the annual savings which can be contributed toward the investment costs.

  If the life-span of the course being considered is greater than the Pay-back Period, a savings should be realized by the USCG. Therefore, the length of the Pay-back Period in relation to the anticipated life-span of the course is very important. The shorter the Pay-back Period in relation to the life-span of the course, the greater the Total Savings will be.

  If the course were to end unexpectedly before the Pay-back Period is reached, such as an unforeseen advance in technology which eliminates the need for the system being trained, the result would be a loss, rather than a savings. It is also important to note that each Pay-back Period calculated in this Cost Model is based on a specific, and constant rate of students taking the course each year. Decreases in student throughput below that considered can have a negative affect on realizing both the Pay-back Period estimated by the Cost Model, and on Total Savings. Therefore, the further into the future the Pay-back Period is estimated, the riskier the chance that the demand for the course will decrease below that estimated, or an event will occur which eliminates the need for the course. For that reason, the two non-cost factors, Annual Student Throughput Rate and Course Life-span, must be estimated as accurately as possible.

- **Rate-of-Return**

  Rate-of-Return is the percentage of investment costs that could be recovered in the first year of operation. In the case of the pilot study, investment costs are associated with designing, developing, and implementing the nonresident version of a AN/WSC-3(v)7 UHF Transceiver Maintenance Course. Implementation includes the initial purchase of course distribution equipment such as the laptop computers. Design and development of the course includes the cost of subject matter experts

which are provided by the USCG. Rate-of-Return is calculated as savings resulting from the combination of Operations and Maintenance Costs (O&M Costs), and Annual Student Costs (Per Student Costs * Annual Student Throughput Rate) in a single year of operating the nonresident course, divided by the nonresident Investment Cost.

- **Annual Cost Avoidance**

Annual Cost Avoidance is the sum of the differences between the O&M Costs of operating the instructor-led resident and nonresident (e.g., interactive CBT, embedded training, correspondence) versions of the course, and the differences between the Annual Student Costs of students taking the instructor-led resident and nonresident versions of the course. The Annual Student Costs of students taking either version of the course is defined as Per Student Costs, multiplied by the Annual Student Throughput Rate being considered. If this data point is negative, operation of the nonresident version of the course would lose money each year.

"Cost Avoidance" was used in the naming of this data point, as opposed to "Savings", because actual savings realized by the USCG is dependent on Pay-back Period relative to Course Life-span. Although Total Savings may be negative based on the Pay-back Period being greater than Course Life-span, the difference between Total Annual Costs for the ILRES and nonresident (e.g., interactive CBT, embedded training, correspondence) versions of the course each year may favor the nonresident course.

- **Total Savings**

Total Savings is the amount of dollars which will be saved over the useful life (Course Life-span) of the course to the USCG, minus the initial investment costs where applicable. The dollar amount presented for this data point is considered an estimate, as it is based on an annual student throughput. For this data point to be accurate, annual student throughput would have to remain consistent over the projected life-span of the course. The actual number of people trained each year is dependent on factors, such as, retention rate of personnel, and on whether the organization is experiencing growth or down-sizing. For example, in Fiscal Year 1997 (FY97), the AN/WSC-3(v)7 UHF Transceiver Maintenance Course was scheduled to convene 12 times, for a total of 72 students (6 students per class). The actual number of students taking the course in FY97 was sixty-four.

- **Net Present Value of Total Savings**

Net Present Value (NPV) of Total Savings is the estimated worth of savings spread out over several years in today's dollars, minus investment (startup) costs in the nonresident version of a course. The nonresident course would be delivered to students at their duty stations via media such as CBT. A definition by example for

NPV is presented in section 5.5 (Using Net Present Value To Compare Training Investment Options) of this report.

Based on discussions with various USCG financial personnel, it was determined that the most beneficial data points to the USCG will be the Pay-back Period and Total Savings. These two data points will be used by the R&DC analysts to delineate between the two methods of delivering training considered in this cost comparison analysis, ILRES and NRCBT.

Since NPV is considered a valuable data point by many analysts in the public sector when comparing investment options, a detailed discussion of the data point NPV of Total Savings is presented in section 5.5 of this report (Using Net Present Value To Compare Training Investment Options). In addressing NPV of Total Savings, a simplified example is used. A brief discussion of the application of NPV in the private sector is presented, NPV is related to application by the USCG training community, and then applies NPV to further analyze projected savings for the two scenarios considered in this comparison.

2.1.2 COST FACTORS

The Cost Model groups costs by type: ILRES, NRCBT. Major cost factors within each of the two groups are further segregated into one of three cost categories: Investment Costs, Operations and Maintenance Costs (O&M Costs), and Per Student Costs. Investment Costs are non-recurring costs associated with the creation of a course (e.g., Instructional System Development Process), and preparations for its implementation (e.g., equipment used to distribute NRCBT course). O&M Costs are recurring costs, which are incurred by the USCG on a yearly basis (e.g., training center operations and personnel). Per Student Costs are recurring costs that are associated with student participation in a training activity (e.g., student transportation, Per Diem). To calculate Annual Student Cost, annual student throughput would be multiplied by Per Student Cost. The sum of O&M Costs and Annual Student Costs would result in the Total Annual Cost to operate a course, or set of courses, per year. The cost factors addressed in the Cost Model are presented in Table 2-1.

Table 2-1 Cost Factors Considered in Cost Model

COST CATEGORY	NRCBT	ILRES
Investment Costs	ISD Process CBT Design & Development USCG SME Support Equipment for Course Distribution	ISD Process USCG SME Support Classroom & Lab Space Classroom & Lab Equipment
Operation & Maintenance Costs	Distribution Center Operations & Personnel Student Support (e.g., Help Desk) Courseware Maintenance	Training Center Operations & Personnel
Per Student Costs	Student Time Duty Station Facilitator Time Shipping of Course Materials Student Materials	Student Time Student Transportation Per Diem Student Materials

2.2.2.1 ILRES Cost Factors

2.2.2.1.1 Instructional Systems Development Process

A new training requirement for which one of two situations exists: either an ILRES version of the course does not exist, or the ILRES course needs to be modified. All or part of the Instructional Systems Development (ISD) Process will need to be performed. The ISD Process involves:

- performing a Task Analysis and Training Needs Assessment,
- selecting appropriate media for delivery of instruction (e.g., instructor-led training, print-based correspondence, video, desktop IVT, computer-based training), and
- developing and writing curriculum plans, course material, and conducting pilot tests of material.

ISD Process is designated as an Investment Cost in the Cost Model.

2.2.2.1.2 USCG Subject Matter Expert Support

The USCG provides subject matter experts (SME) to assist in the ISD Process. The USCG SME works closely with Instructional Designers in the design and development of the ILRES course. The SME provides technical information and reviews materials (e.g., course content, lesson plans). The cost of the SME involvement, which includes both time and travel, is accounted for in the USCG SME Support cost factor. The USCG SME Support is designated as an Investment Cost in the Cost Model.

2.2.2.1.3 Classroom & Lab Space

The proportionate cost of facility space where the ILRES course resides is to be accounted for on the ILRES side of the cost comparison. This proportionate cost includes classroom, lab space, and common space such as hallways, lounges, rest rooms, and the instructor's office. If the facility is owned by the USCG, the Classroom & Lab Space cost factor is designated as an Investment Cost in the Cost Model. If the space is leased, the cost factor is designated as an O&M Cost in the Cost Model.

2.2.2.1.4 Classroom & Lab Equipment

The cost of equipment (e.g., mockup of system being trained) used in the classroom and/or lab to train students. Classroom & Lab Equipment is designated as an Investment Cost in the Cost Model.

2.2.2.1.5 Training Center Operations & Personnel

A proportionate cost to operate and staff a training center where the ILRES course resides. This data point includes the cost of the instructors for the course. There are strong arguments to treat Training Center Operations & Personnel costs as an O&M Cost, or a Per Student Cost. The Cost Model provides an option to enter this data point as either an O&M Cost or Per Student Cost.

The USCG training centers feel these costs are an O&M Cost because whether or not the course runs during a given year, operations and personnel costs of the training center will not be impacted. For purposes of this cost comparison analysis, Training Center Operations & Personnel is entered as an O&M Cost in the Cost Model. The only exception will be during Cost Model runs to explore the difference between treating this data point as an O&M Cost and a Per Student Cost. The results of that Cost Model run, in which Training Center Operations & Personnel is treated as a Per Student Cost, can be found in section 4.3 of this report (Sensitivity Analysis Model Runs).

Note, in most tables presented in this report, to save space, this cost factor is referred to as "TC Operations & Personnel".

2.2.2.1.6 Student Transportation

Student transportation is the cost of transporting a student between the student's assigned duty station and the training center. Student transportation is designated as a Per Student Cost in the Cost Model. According to representatives from two Coast Guard training centers (TRACEN Petaluma and RTC Yorktown), it is rare that ILRES students attending C-Schools will take back-to-back courses at a training center. Taking courses back-to-back would reduce the consideration of travel costs per course by the number of courses taken. Since back-to-back courses at the same training center is a rare event, travel costs regarding a single IRES course are considered at 100 percent of cost.

2.2.2.1.7 Student Time

The cost associated with the length of time it takes a student to complete the course. For the ILRES course, student time includes both the length of the ILRES course, and the student's travel time between the duty station and the resident training center. Student Time is designated as a Per Student Cost in the Cost Model.

2.2.2.1.8 Per Diem

The USCG gives each student attending a training center a daily Meals and Incidental Expense (M&IE) allowance. Students are given two different rates for M&IE, depending on whether its a travel day, or a full day at the training center. On travel days, which are the day before the class convenes, and the last day of the class, the student receives a percentage of the local M&IE rate where the training center is located. On the full days at the training center, the student receives a lower M&IE rate since training centers usually have a mess hall. As a result, this cost factor is divided into two data points: at Training Center, and Travel Days. Per Diem is designated as a Per Student Cost in the Cost Model.

2.2.2.1.9 Student Materials

Cost of materials that are consumed in the process of training, or become the property of the student upon completion of the training.

One of the materials that becomes the personal property of the student upon completion of the AN/WSC-3 course is the Student Guide. The Student Guide (booklet) was developed by TRACEN Petaluma, and is given to each student who takes the AN/WSC-3 course. It is designed to aid the student in completing the course. The guide contains general information, troubleshooting job-aids, and clarifies information contained in the AN/WSC-3 technical manuals that are provided by the U.S. Navy. This booklet also provides information specific to the USCG that is not contained in the U.S. Navy technical manuals.

2.2.2.2 NRCBT Cost Factors

2.2.2.2.1 Instructional Systems Development Process

A new training requirement for which either an ILRES version of the course does not exist, or the ILRES course needs to be modified. All or part of the Instructional Systems Development (ISD) Process will need to be performed. The ISD Process involves:

- performing a Task Analysis and Training Needs Assessment,
- selecting appropriate media for delivery of instruction (e.g., instructor-led training, correspondence, IVT, interactive CBT), and
- developing and writing curriculum plans, course material, and conducting pilot tests of material.

ISD Process is designated as an Investment Cost in the Cost Model.

2.2.2.2.2 CBT Design & Development

Costs incurred to design and develop a NRCBT course. CBT Design & Development is designated as an Investment Cost in the Cost Model.

2.2.2.2.3 USCG Subject Matter Expert Support

The USCG provides subject matter experts (SME) to assist in both the ISD Process, and the design and development of the NRCBT version of the course. The USCG SMEs work closely with Instructional Designers in performing these two tasks. The SMEs provide technical information and reviews materials (e.g., course content, storyboards). The cost of the SME involvement, which includes both time and travel, is accounted for in the USCG SME Support cost factor. The USCG SME Support is designated as an Investment Cost in the Cost Model.

2.2.2.2.4 Equipment for Course Distribution

The cost of equipment required to distribute the NRCBT course to students at their duty station. For the pilot study, this included the cost of multimedia laptop computers and shipping cases. Equipment for Course Distribution is designated as an Investment Cost in the Cost Model.

2.2.2.2.5 Courseware Maintenance

Cost to maintain the CBT courseware, including revision of course curriculum and printing of CD-ROMs and other peripheral materials (e.g., student handbook). This includes the cost to periodically update course material over the useful life of a course to an organization (USCG). Courseware Maintenance is designated as an O&M Cost in the Cost Model.

2.2.2.2.6 Student Support

Students taking NRCBT courses may require assistance with technical questions. This data point is the O&M Cost to operate and staff a Help Desk. Student Support is designated as an O&M Cost in the Cost Model.

2.2.2.2.7 Distribution Center Operations & Personnel

A proportionate cost to operate and staff a distribution center for the NRCBT course. The Cost Model provides an option to treat this cost as either an O&M Cost or a Per Student Cost.

Being consistent with how this data point is treated on the ILRES side of the cost comparison analysis, Distribution Center Operations & Personnel was entered as an O&M Cost.

Note, in most tables presented in this report, to save space, this cost factor is referred to as "DC Operations & Personnel."

2.2.2.2.8 Shipping of Course Materials

The cost of shipping the CBT courseware and relative materials (including laptop computer and technical manuals) round-trip between a distribution center and the student's duty station. Shipping is designated as a Per Student Cost in the Cost Model.

2.2.2.2.9 Student Time

The cost associated with the length of time it takes a student to complete the course. Student Time is designated as a Per Student Cost in the Cost Model.

2.2.2.2.10 Duty Station Facilitator Time

The facilitator is a person assigned at the duty station to receive and return course materials, as well as, check on student progress. Duty Station Facilitator Time is designated as a Per Student Cost in the Cost Model.

Note, in a few of the tables presented in this report, to save space, this cost factor is referred to as "DS Facilitator Time".

2.2.2.2.11 Student Materials

Cost of materials that are consumed in the process of training, or become the property of the student upon completion of the training. For the NRCBT course, these materials include the Student Guide and CD-ROM course disk. The Student Guide (booklet), which was developed by TRACEN Petaluma, is given to each student who takes the AN/WSC-3 course. This guide is designed to aid the student in completing the course. It contains general information, troubleshooting job-aids, and clarifies information contained in the AN/WSC-3 technical manuals that are provided by the U.S. Navy. The Student Guide also provides information specific to the USCG that is not contained in the U.S. Navy technical manuals.

The CD-ROM course disk contains the CBT courseware. TRACEN Petaluma is considering giving copies of the CD-ROM to each student whom takes the NRCBT version of the course. This would enable the students to use the courseware for refresher training in the future. Refresher training is an advantage of CBT technology that was not evaluated in the pilot study.

Both the Student Guide and the CD-ROM copy of the CBT courseware become the personal property of the student upon completion of the training.

3 GENERATION OF COST FACTOR VALUES BASED ON DATA COLLECTED

This section:

1. Identifies data sources that provided information used in generating values for the various factors considered in the Cost Model.

2. Describes the process used to validate collected data. This data was used to generate values for the cost factors contained in the Cost Model.
3. Discusses use of Standard Personnel Costs Model in determining personnel costs.
4. Discusses values used for two important non-cost factors considered in the Cost Model, Annual Student Throughput Rate and Course Life-span.
5. Describes how dollar values for each cost factor considered in the Cost Model was generated. The dollar values generated and used for each of the cost factors contained in the Cost Model are presented in Tables 3-1(a) and 3-1(b).

Table 3-1(a) Values Generated for ILRES Cost Factors

COST FACTOR			COST
Investment			
ISD Process		Unobtainable	$ 0.00
USCG SME Support		Unobtainable	$ 0.00
Classroom & Lab Space		Estimated	$ 176,000.00
Classroom & Lab Equipment		Actual	$ 502,000.00
Annual			
Training Center Operations & Personnel		Estimated	$ 150,206.40
Per Student			
Student Time		Actual	$ 730.00
Student Transportation		Estimated	$ 500.00
Per Diem - Training Center		Actual	$ 44.00
Per Diem - Travel Days		Actual	$ 48.00
Student Materials		Actual	$ 65.50

Table 3-1(b) Values Generated for NRCBT Cost Factors

COST FACTOR			COST
Investment			
ISD Process		Unobtainable	$ 0.00
CBT Design & Development		Actual	$ 190,000.00
USCG SME Support		Estimated	$ 43,017.40
Equipment for Course Distribution (For Annual Student Throughput of 72)		Estimated	$ 33,216.00
Annual			
Courseware Maintenance		Estimated	$ 19,000.00
Student Support (e.g., Help Desk)		Estimated	$ 50,976.00
Distribution Center Operations & Personnel		Estimated	$ 5,282.64
Per Student			
Student Time		Estimated	$ 237.25
Duty Station Facilitator Time		Estimated	$ 98.04
Shipping of Course Materials		Actual	$ 72.00
Student Materials		Estimated	$ 20.00

3.1 DATA SOURCES

Data used in the cost comparison was collected from multiple sources. Contributing sources were:

- USCG Headquarters Office of Training and Performance Consulting (G-WTT)
  Washington, D.C.
- USCG Headquarters Office of Financial Systems (G-CFS)
  Washington, D.C.
- U.S.C.G. Training Center (TRACEN Petaluma)
  Petaluma, California
- U.S.C.G. Institute
  Oklahoma City, Oklahoma
- U.S.C.G. Research And Development Center (R&DC)
  Groton, Connecticut
- U.S.C.G. Academy (CGA)
  New London, Connecticut
- Naval Air Warfare Center (NAWC)
  Orlando, Florida

3.2 DATA VALIDATION

The process of validating the data was performed in three steps. The first step was to run the Cost Model using data received from various sources. The R&DC analysts reviewed the results of the model run and the data used. They then developed a list of questions and issues that needed to be reconciled with the various data sources.

The second step was a series of meetings between the R&DC analysts and the various data sources. The purpose of the meetings was to discuss and resolve the questions and issues identified in Step 1. At many of these meetings, the Cost Model, including data used, and the results of the Cost Model run, were presented.

The third and final step was the revision of the Cost Model and data, based on the results of those meetings.

3.3 STANDARD PERSONNEL COSTS MODEL

The Standard Personnel Costs (SPC) Model, which was developed by the USCG Headquarters' Office of Financial Systems (G-CFS), calculates the fully burdened rates for both military and civilian USCG personnel. The SPC Model is used by the USCG, as part of the budget build process, to determine costs for personnel in a given Fiscal Year. All personnel costs used for this cost comparison analysis were based on Fiscal Year 1997 (FY97), and were generated using the SPC Model provided by G-CFS.

To obtain hourly rates, the fully burdened rate provided by the SPC Model was divided by 2,080 hours (one-man year).

3.4 NON-COST FACTORS

Non-cost factors which influence costs and savings are Annual Student Throughput Rate, Course Life-span, and Course Length. Course Life-span is the length of time (years) that a particular course will be used by the USCG to train its personnel. Length of time is dependent on the useful-life to the USCG of the equipment or system being trained. The U.S. Navy liaison, at the USCG Telecommunications and Information Systems Command (G-TISCOM), felt that the AN/WSC-3(v)7 UHF transceiver will be used by the USCG for at least the next ten years, and probably beyond that point. Based on this information, a conservative estimate of a seven-year Course Life-span was entered into the Cost Model.

Annual Student Throughput Rate is the anticipated number of students who will take a given course each year. Annual Student Throughput Rate, when factored with Per Student Cost and Course Life-span of a given course (Course Life-span * (Annual Student Throughput Rate * Per Student Cost)), determines Total Student Cost for a particular version of the course (i.e., ILRES, NRCBT). The anticipated Annual Student Throughput Rate for the AN/WSC-3(v)7 UHF Transceiver Maintenance Course in FY97 was 72 students (provided by TRACEN Petaluma).

Course Length for the ILRES course is the published length of the course in days. For purposes of the cost comparison effort, Course Length is set to five days (40-hours) for the ILRES version of the AN/WSC-3 course based on the published length of the course at TRACEN Petaluma.

3.5 GENERATION OF COST FACTOR VALUES

Cost data can be classified as either: Actual Costs, Estimated Costs, or Unobtainable Costs. Actual Costs are costs that are incurred and recorded. Wherever possible, Actual Costs are used. Estimated Costs are based on assumptions and educated opinions. Unobtainable Costs are costs for which recorded data was unavailable, and the R&DC analysts could not make an estimate based on the limited information received.

3.5.1 ILRES COST DATA

3.5.1.1 Actual Costs

3.5.1.1.1 Classroom & Lab Equipment

There are two sets of costs generated in the Cost Model for Classroom & Lab Equipment; Existing Equipment, Additional Equipment.

Existing Equipment

The first set of costs is for equipment that already exists in the classroom or lab. For the AN/WSC-3 resident course, the existing equipment includes nine AN/WSC-3(v)7 UHF transceivers and peripheral equipment (e.g., voltage test meters). Six of the transceivers are used in the training of students and the other three transceivers serve as backups. Costs, such as desks and chairs used in the classroom and lab were not considered in this cost analysis. The existing equipment is adequate to train six students per class, with each class being one-week in length. For the existing equipment, actual costs provided by TRACEN Petaluma were used in the Cost Model runs.

As stated, nine AN/WSC-3 UHF transceivers already exist in the inventory for the ILRES course. The U.S. Navy provided these transceivers to the USCG at no cost. If the U.S. Navy had not provided these transceivers, the USCG would have had to purchase each of them at a cost of $35K. Therefore, the cost of the transceivers is accounted for in the Cost Model.

The total cost of the WSC-3 UHF transceivers is calculated in the Cost Model as the number of transceivers (i.e., 9 transceivers), multiplied by the cost per unit (i.e., $35K). The total cost of the existing equipment is calculated in the Cost Model as the total cost of the WSC-3 UHF transceivers plus the cost of the existing peripheral equipment (i.e., $187K). Costs for both the unit cost of the AN/WSC-3(v)7 UHF transceiver, and the total cost for the peripheral equipment, was provided by TRACEN Petaluma, using the following reference sources:

- FEDLOG CD-ROM DB Version 10.0 (2/16/96)
- USCG EEIS Maintenance System
- Procurement Request # 2194494QTEA62 (IFR Systems, Inc.)

Additional Equipment

Existing equipment is adequate to train six students per class, of which each class is one week in length. However, if the Annual Student Throughput Rate were to exceed 6 students per class, or rise above 300 students (6 students per class * 50 training weeks per year), additional equipment would be required. Since this would be additional equipment that does not exist as part of the current inventory at the resident training center, expending of additional funds for this equipment could be avoided by an investment in a NRCBT version of the course. A formula was developed by the R&DC analysts that would estimate the additional number of AN/WSC-3 UHF transceivers required based on increased student throughput. However, the R&DC analysts did not have the time or the resources to create a reasonable formula for estimating the cost of additional peripheral equipment. This estimate is the second set of costs generated by the Cost Model for Classroom & Lab Equipment.

The number of additional AN/WSC-3(v)7 UHF transceivers is calculated in the Cost Model using the following steps:

1. If Annual Student Throughput Rate considered is less than or equal to maximum number of students per class (i.e., 6 students) multiplied by number of training weeks in a year (i.e., 50 weeks), then there is no need for additional transceivers and the value is zero. If the Annual Student Throughput Rate is greater, then go to Step (2).
2. Number of transceivers that are used for training students (i.e., 6 transceivers) is multiplied by the number of training weeks in a year. Although there are nine transceivers in the ILRES course's inventory, as stated above, three of those transceivers serve as spares. The Cost Model was not set up to estimate spares.
3. Subtract Annual Student Throughput Rate from the result of Step (2).
4. Divide the result of Step (3) by the number of training weeks in a year. If the resulting value is not a whole number, then a function (Ceiling) is used to round the result to the next highest whole number value. The result of Step (4) is the number of additional transceivers required.
5. The result of Step (4) is then multiplied by the cost of an AN/WSC-3(v)7 UHF transceiver to determine total cost of the additional transceivers required.

Based on the various Annual Student Throughput Rates that were considered in the Cost Model, one additional transceiver is required at and above an annual throughput rate of 312 students. This results in an additional cost of $35,000.

3.5.1.1.2 Student Time

Student Time is calculated in the Cost Model by multiplying the length of time the student is designated to be in a Temporarily Assigned Duty (TAD) status to attend the ILRES course by a student hourly rate.

The student hourly rate is based on the demographics of the AN/WSC-3 course in FY97. The demographic data, which is presented in Table 3-2, was provided by TRACEN Petaluma. Electronic Technician Third Class (ET3) made-up more than 50 percent of the total students who took the AN/WSC-3 course in FY97. Therefore, an hourly rate was calculated for the ET3, using the SPC Model.

Table 3-2 Demographics of AN/WSC-3 Course in FY97

Student Rate	Number of Students
Electronic Technician First Class	12
Electronic Technician Second Class	10
Electronic Technician Third Class	32
Electronic Technician Non Rate	10
Total Students	64

The ILRES version of the AN/WSC-3(v)7 UHF Transceiver Maintenance Course requires the student to be at least six days TAD, which includes a day of travel the day before class convenes. Since an hourly rate is generated for personnel based on a 40-hour work week, 40 hours was entered into the Cost Model as the time charged for the student attending the resident AN/WSC-3 course. TRACEN Petaluma provided information to support this assumption.

3.5.1.1.3 Per Diem

Berthing quarters are available at most USCG training centers at no charge for personnel attending a resident course. However, a prorated charge, based on Per Diem for Meals and Incidental Expenses (M&IE) Allowance, is assessed students for food acquired at the Mess Hall. Per Diem is broken into two categories; At Training Center, and During Travel. FY97 per diem values were used.

At Training Center

Calculated in the Cost Model using the following two steps:

1. Since the last day of a course is considered a travel day for the student, the number of days at the training center are calculated as the course length in days, minus one (i.e., 4 days).
2. The result of Step (1) is then multiplied by $11 a day per diem (i.e., $9 food and $2 incidental), based on information obtained from the Joint Federal Travel Regulations for FY97.

During Travel

Travel days are the day before the class convenes, and the last day of the course. This equates to two days of travel. Seventy-five percent of the full M&IE per diem rate for the location where the ILRES course is located (i.e., $32), is given to the student for the two travel days. Thus, the location per diem is multiplied by 75 percent, and then multiplied by two days.

CGA provided information on how the per diem rate is calculated for students on travel days, and how those travel days are accessed. TRACEN Petaluma confirmed this. Local per diem for M&IE in the Petaluma, California, area was obtained from the GSA Web Site which publishes per diem rates for FY97.

3.5.1.1.4 Student Materials

The value for this data point was provided by TRACEN Petaluma, and was directly entered into the Cost Model.

3.5.1.2 Estimated Costs

3.5.1.2.1 Classroom & Lab Space

How this cost is applied in the Cost Model is dependent on two factors:

1. If the classroom and lab space reside in a building and/or facility that the USCG owns, then the cost is entered into the Cost Model as an Investment Cost.
2. If the classroom and lab space reside in an area leased by the USCG, then the cost is entered into the Cost Model as an O&M Cost.

The AN/WSC-3 resident course resides in an USCG owned facility. Therefore, Classroom & Lab Space will be entered in the Cost Model as an Investment Cost. The proportionate cost to be accounted for on the ILRES side of the cost comparison analysis is calculated by the user. Then the user enters the calculated proportionate cost into the Cost Model. The following steps were performed in calculating the cost:

1. Obtain square footage for classroom and lab space (i.e., approximately 1,224 square feet). Obtain square footage for overall building (i.e., 97,679 square feet). These data points were obtained from blueprints provided by TRACEN Petaluma.
2. To calculate the percentage of the building space occupied by the course, divide the combined square footage for the classroom and lab, by the total square footage of the building.
3. Multiply the result in Step (2) by the dollar replacement value of the building (i.e., $14 million). TRACEN Petaluma provided replacement value for the building.

3.5.1.2.2 Training Center Operations & Personnel

There are two sets of costs generated in the Cost Model for Training Center Operations & Personnel: Existing Infrastructure, and Additional Instructors.

Existing Infrastructure

Three data points (parameters) are used in the Cost Model to calculate the proportionate cost for a training center's operation and personnel costs: FY97 projected student throughput for the course, resident course length, cost per student day.

An Annual Student Throughput Rate of 72 students was entered into the Cost Model. This was based on the number of classes scheduled for FY97 (i.e., 12 classes) and the maximum student load per class (i.e., 6 students).

A course length of 5 days was entered into the Cost Model. Five days is the published maximum length for the resident AN/WSC-3 course.

The user must calculate the cost per student day before entering that data point into the Cost Model. This calculation is performed using the following six steps:

1. Personnel costs were obtained by first totaling the number of personnel for each pay category. This was accomplished using the FY97 Personnel Allowance List (PAL) for TRACEN Petaluma, which was provided by G-WTT.
2. The results from Step (1) were entered into the SPC Model to determine the total personnel costs for the training center. Since AFC 30 funds were already accounted for in the TRACEN Petaluma operations budget, AFC 30 fund calculations in the SPC Model were manually set to zero to avoid double counting. TRACEN Petaluma brought up the concern of double counting during a review of the Cost Model. TRACEN Petaluma and R&DC verified the double counting concern with G-CFS. The result of Step (2) is the total cost of staffing a training center based on the FY97 PAL.
3. Sum the cost of operating a training center, which was obtained from TRACEN Petaluma, with the cost of staffing a training center (result of Step (2)).
4. Divide the result of Step (3) by the number of training days in a year (i.e., 260 days). The result of Step (4) will be the cost per training day for operating and staffing a training center.
5. Divide the result of Step (4) by the average number of students at the training center per training day (i.e., 245 students). TRACEN Petaluma provided the average number of students per day. The result of Step (5) will be the cost per student per training day to operate and staff a training center.
6. Result of Step (5) is entered into the Cost Model along with Course Length and Annual Student Throughput Rate.

Once the user enters the three parameters into the Cost Model, the model calculates Training Center Operations & Personnel costs using the following four steps:

1. Multiply Cost Per Student Per Training Day, by Course Length (i.e., 5 days).
2. Multiply result from Step (1) by Annual Student Throughput Rate.
3. Since student materials are being accounted for in the Cost Model as a Per Student cost, the cost of student materials needs to backed out of the result of Step (2). This is accomplished by first multiplying the number of students predicted to take the AN/WSC-3 course in FY97 (i.e., 72 students) by the Student Material cost entered in the Cost Model.
4. Subtract the result from Step (3) from the result of Step (2).

Unique to only a few courses at TRACEN Petaluma, the U.S. Navy provides $10,000 annually to the AN/WSC-3 course for the maintenance of the nine AN/WSC-3(v)7 UHF transceivers which are used in the resident lab to train students. The $10,000 is separate of the TRACEN Petaluma budget. If the U.S. Navy were not providing this funding, the USCG would have to assume this annual expense. Although this separate funding could have been entered into the Cost Model, the Analyst chose to be conservative on this issue and did not use this data point in the Cost Model runs for this report. The Analyst's decision was based on the fact that only a few courses

received unique funding of this type, and therefore would not be representative in estimating the potential impact of replacing a large number of existing ILRES courses in the USCG with NRCBT.

TRACEN Petaluma provided information on the number of training days and the average number of students. It should be noted that when calculating cost per student per training day for training center operations and personnel costs, the result is dependent on whether or not the data used was associated with a high, medium, or low student throughput year for a particular training center. The R&DC analysts did not have the time, resources, or project scope to explore how student throughput levels, sustained over a period of time, would affect the infrastructure costs of a training center.

Additional Instructors

Existing personnel is adequate to meet a student throughput rate of 72 students per year. However, if an annual student throughput rate greater than 72 students were considered, at some point the larger student throughput rate would, at the very least, require an additional instructor. A formula was developed by the R&DC analyst that would estimate the additional number of instructors required, based on the Annual Student Throughput Rate considered in the Cost Model run.

The number of additional instructors is calculated in the Cost Model using the following steps:

1. Annual Student Throughput Rate being considered, divided by maximum students per class (i.e., 6 students). The result is the number of classes required per year based on the Annual Student Throughput Rate considered.
2. Sum length of resident class in days (i.e., 5 days) and instructor prep time required before a class convenes (i.e., 2 days). TRACEN Petaluma provided prep time. The result is the length of time in days an instructor requires per class.
3. Multiply the result from Step (1) by the result of Step (2). The result is the total number of instructor days required, based on the Annual Student Throughput Rate.
4. Multiply training weeks in year (i.e., 50 weeks) by the number of days in a typical workweek (i.e., 5 days). The result is the number of training days in a year.
5. Divide the result of Step (3) by the result of Step (4). The result is the number of instructors required, based on the Annual Student Throughput Rate considered. If the result is not a whole number, then a function (Floor) is used to convert the result to a whole number (e.g., 5.23 is rounded to 5). Note, if the value is less than one whole instructor, the result of the rounding would be zero, which indicates that an additional instructor is not required.

Based on the various Annual Student Throughput Rates that were considered in the Cost Model runs for this cost comparison, one additional instructor was required at and above an annual throughput rate of 216. The cost of the additional instructor was $47,493.

3.5.1.2.3 Student Transportation

Cost to transport the student between the student's duty station and the training center. This data point was provided by G-WTT, and is based on the value used in the budget build process at USCG Headquarters. The value was entered directly into the model.

3.5.1.3 Unobtainable Costs

3.5.1.3.1 Instructional Systems Development Process

Analysts were unable to establish a cost for the Instructional Systems Design (ISD) Process. Therefore, assuming that similar costs would have to be incurred by both the ILRES and NRCBT versions of the course, this cost was considered a "wash" between the resident and NRCBT versions of the course. Therefore, the value entered in the Cost Model for this data point is zero ($0).

It should be noted that this data point would only be considered in the cost comparison analysis when there is a new training requirement. Under such a scenario involving a new training requirement, the resident version of the course either does not exist or has to be modified.

3.5.1.3.2 USCG Subject Matter Expert Support

For a resident course this data point is relative to the Instructional Systems Development (ISD) Process. Since the R&DC analysts were unable to come up with a value for the ISD Process, they could not generate a value for the CG SME. The value entered for this data point is zero ($0).

3.5.2 NRCBT COST DATA

3.5.2.1 Actual Costs

3.5.2.1.1 CBT Design & Development

CBT Design & Development is calculated in the Cost Model by multiplying the total number of CBT instructional hours by the cost per CBT instructional hour.

The number of CBT instructional hours and the cost per CBT instructional hour are based on the costs incurred by the R&DC when the R&DC converted the existing resident AN/WSC-3 course to a NRCBT version. An R&DC contractor, Analysis & Technology, Inc., with the assistance of TRACEN Petaluma, performed the conversion. The conversion effort totaled $190K, which includes travel. The resulting NRCBT version of the course was priced at ten (10) hours of CBT instruction, a rate of $19K per CBT instructional hour.

It should be noted that the cost for developing a CBT course is dependent on several factors. Among those factors are:

1. The number of CBT instructional hours for a given course is an important factor in determining the total cost to design and develop a CBT course. Economies of scale create a substantial difference in the cost per CBT instructional hour. For example, a CBT course that will be two (2) hours in length will probably cost in the range of $34K per CBT instructional hour. While the ten (10) hour course developed for the pilot study costs about $19K per CBT instructional hour. This statement is based on discussions with the R&DC contractor, Analysis & Technology, Inc., and representatives of various Federal Agencies (e.g., NAWC, FBI's National Security Division) who have experience in this area.
2. Cost is dependent on whether or not the resident version of the course exists. If this is a new training requirement, for which a resident version of the course may not exist, a Task Analysis and other efforts would have to be performed before design and development of the CBT course can take place.
3. Price per hour of CBT instruction is highly dependent on the complexity level of the course, such as inclusion of sophisticated learner control strategies, and whether the CBT courseware is simulating an automated computer system. For example, branching was debated in the early stages of the pilot study. Branching can increase effectiveness of CBT courseware, but branching is an expensive option. It was determined after great debate by the Instructional Design team for Analysis & Technology, Inc., and the Coast Guard Project Team (i.e., G-WTT, R&DC, and TRACEN Petaluma), that although branching would have been nice, it was not necessary for the course being converted for the pilot study. This decision turned out to be correct as, based on the results of the pilot study's effectiveness evaluation, the NRCBT version of the course proved to be equivalent to the ILRES version of the course.
4. Quality of the CBT course will affect the price per CBT instructional hour.

3.5.2.1.2 Equipment for Course Distribution

Equipment for Course Distribution is the total cost for equipment used to distribute the nonresident course to students at their duty stations. In the case of the pilot study, the NRCBT version of the AN/WSC-3 resident course was delivered to the student at the duty station via a multimedia laptop computer. To decrease the risk of damage to the laptop computers during shipping, a plastic shock resistant shipping case was purchased for each laptop computer which would be shipped between the distribution center and the participating duty stations. Cost for a laptop computer and shipping case, which are presented in Table 3-3, were based on costs incurred by the R&DC in performing the pilot study.

Table 3-3 Equipment for Course Distribution

Equipment	Cost Per Unit
Laptop Computer	$ 4,000
Shipping Case	$ 152

Costs for equipment that was used to distribute the NRCBT course were calculated in the Cost Model using the following three steps:

1. The number of laptop computers is dependent on the turnaround time. Turnaround time includes shipping time, time the laptop computer is kept at the duty station to perform the training, and the handling time required at the distribution center. Based on the experience of the pilot study, the total turnaround time was four (4) weeks for each laptop computer. To be conservative, for purposes of this cost comparison, the turnaround time entered into the Cost Model was five (5) weeks. Five weeks is then divided into the number of training weeks in a year (i.e., 50 weeks) to determine how many students a single laptop computer can serve per year. If the result is a fraction, the result is rounded to the next highest whole number.
2. The number of laptop computers required is also dependent on the number of students who will take the course annually. The considered Annual Student Throughput Rate for a given course is divided by the result of Step (1). If the result is a fraction, the result is rounded to the next highest whole number. This is the number of computers required for the given student throughput.
3. The result from Step (2) is then multiplied by the sum of the cost for a laptop computer and shipping case.

Since the number of laptop computers and shipping cases required is dependent on the Annual Student Throughput Rate being considered, the result of the above calculation is contained in a sliding-scale table within the Cost Model. A copy of that table is presented in Table 3-4.

Table 3-4 Cost of Equipment for Course Distribution

Number of Students	Equipment Required	Cost of Equipment		Number of Students	Equipment Required	Cost of Equipment
36	4	$ 16,608		**180**	18	$ 74,736
48	5	$ 20,760		**192**	20	$ 83,040
60	6	$ 24,912		**204**	21	$ 87,192
72	8	$ 33,216		**216**	22	$ 91,344
84	9	$ 37,368		**228**	23	$ 95,496
96	10	$ 41,520		**240**	24	$ 99,648
108	11	$ 45,672		**252**	26	$ 107,952
120	12	$ 49,824		**264**	27	$ 112,104
132	14	$ 58,128		**276**	28	$ 116,256
144	15	$ 62,280		**288**	29	$ 120,408
156	16	$ 66,432		**300**	30	$ 124,560
168	17	$ 70,584		**312**	32	$ 132,864

The R&DC analysts did not include in the Cost Model a formula to account for additional laptop computers that may be required in the future, due to wear and tear of the laptop computers which were purchased as part of the initial investment in the NRCBT course. The analysts felt that the absence of such a formula is offset by the exclusion of the $10,000 provided annually for maintenance of the nine AN/WSC-3 UHF transceivers used in the resident classroom (refer to section 3.5.1.2.2 of this report, Training Center Operations & Personnel). In addition, no formula was developed for calculating replacement costs of ILRES equipment in the future due to wear and tear of resident classroom and lab equipment (e.g., peripheral equipment).

3.5.2.1.3 Student Time

Student Time is calculated in the Cost Model by multiplying the average length of time students take to complete the NRCBT course by a student hourly rate.

The arithmetic mean (average) length of time it took for 17 students to complete the NRCBT version of the AN/WSC-3 course at their duty station was 11 hours (i.e., rounded off from 10 hours and 55 minutes). This data point was provided by the pilot study, as the CBT courseware program recorded student times without the knowledge of the participating student. Upon return of the laptop computer to TRACEN Petaluma, which served as the distribution center during the study, TRACEN personnel accessed the files where the time data was collected, and relayed the file to the R&DC for processing. The recorded time was then used to calculate an average time for students to complete the NRCBT version of the AN/WSC-3 course at their duty stations. This average time could be considered a worst case scenario, as one student admittedly forgot to shut down the CBT course, resulting in an unusually high amount of training time being recorded for that student.

The average length of time (i.e., 11 hours) to complete the CBT portion of the course was then added to the maximum amount of time (i.e., 2 hours) deemed necessary to complete the hands-on portion of the NRCBT course. Total number of hours to complete the NRCBT version of the course was entered into the Cost Model as 13 hours.

Student hourly rate is based on the demographics of the AN/WSC-3 course in FY97. TRACEN Petaluma provided the demographic data. Electronic Technician Third Class (ET3) made-up more than 50 percent of the total students who took the AN/WSC-3 course in FY97 (refer to Table 3-1, Demographics of AN/WSC-3 Course in FY97). Therefore, an hourly rate (i.e., $18.25) was calculated for the ET3 using the SPC Model.

3.5.2.2 Estimated Costs

3.5.2.2.1 USCG Subject Matter Expert Support

The Cost Model provides for data input regarding both primary and secondary subject matter experts (SME). The primary SME would be involved in the detailed (daily) activities regarding support of the CBT design and development effort. The role of the secondary SME would focus

mainly on administrative functions. User input requirements for this cost factor are the number of hours required and the hourly rates for each of the SME, and the total cost of travel for the two SMEs. The Cost Model will use this data to calculate a value for the USCG SME Support cost factor.

For purposes of this cost comparison, the R&DC analyst has assumed that the primary SME would be an ET1, and the secondary SME would be an Electronic Technician Chief (ETC). The number of hours estimated and the hourly rates entered in the Cost Model for the two SMEs are listed in Table 3-5. The rates of the SME and the amount of time required for each role was based on observations made by the R&DC analyst during the analyst's involvement in the design and development process of the pilot study. These estimates are also based on discussions with participants such as the R&DC contractor, who designed and developed the CBT version of the course. The time required for the primary SME is equivalent to the length of time it took to design and develop the NRCBT version of the AN/WSC-3 course, nine months. Hourly rates for the ET1 and the ETC were obtained using the SPC Model.

Table 3-5 SME Time Estimates and Hourly Rates

	HOURS	HOURLY RATE
Electronic Technician Chief	100	$ 27.23
Electronic Technician First Class	1,440	$ 24.51

Based on SME travel requirements for the pilot study, total travel costs for the SME is estimated at $5,000.

3.5.2.2.2 Courseware Maintenance

Based on discussions with the Naval Air Warfare Center (NAWC) and other organizations, the R&DC analyst determined that annual courseware maintenance is estimated based on a percentage of the cost for designing and developing the courseware. The Cost Model is set up to calculate the courseware maintenance cost upon entry of the percentage value by the user.

NAWC uses 10 percent as their data point for estimating courseware maintenance. This percentage includes costs associated with periodic updates of the course (e.g., revising course curriculum) over the useful life of the course. There is no hard data to support the 10 percent figure, but this figure is accepted and used by the economist community. That value was used in the Cost Model runs for this cost comparison.

3.5.2.2.3 Student Support

The user enters the value for this cost factor directly into the Cost Model.

For purposes of this cost comparison, it is assumed that an Electronic Technician First Class (ET1) would serve in this role. This assumption was made based on observations by the R&DC analysts during the pilot study. The analysts observed that instructors for the resident version of

the course are usually an ET2 or higher. Since an ET1 should have the background and experience to assist students with technical questions, the analysts chose to be conservative with this decision and used the ET1 for this data point.

Making another conservative assumption regarding the amount of time required of the ET1 to serve in the support role, a full man-year (i.e., 2,080 hours) was entered into the Cost Model. This assumption is considered conservative as, more realistically, the ET1's time would be split among several nonresident courses (e.g., interactive CBT, IVT) and/or other duties.

The fully burdened rate for an ET1 of $50,976, which was obtained using the SPC Model, was entered into the Cost Model.

No costs were generated for office space and other materials that would be required for setting up a Help Desk to support NRCBT. Once the USCG has determined what the infrastructure to support NRCBT will look like, a more accurate estimate can be made for this cost factor.

3.5.2.2.4 Distribution Center Operations & Personnel

The USCG Institute manages and distributes USCG correspondence courses. Activities similar to the management and distribution of correspondence courses will be required by a distribution center for the NRCBT courses. Therefore, costs associated with the USCG Institute were used for this estimate.

The user must calculate the cost per student before entering that data point into the Cost Model. Calculation of the cost per student was performed by the R&DC analyst using the following three steps:

1. Personnel costs were obtained by totaling the number of personnel for each pay category using the FY97 Personnel Allowance List (PAL) provided by the USCG Institute. The totals were then entered into the SPC Model to determine the total personnel costs for the training center, which was $1,766,433.
2. Sum the costs for operating the distribution center for a FY97 (i.e., $875,000) and the result of Step (1). The USCG Institute provided FY97 operation costs for the training center.
3. Divide the result of Step (2) by the number of students processed annually (i.e., 36,000 students). The USCG Institute provided the number of students processed. The result of Step (3) is the per student cost.

The per student cost is entered into the Cost Model along with the number of students (i.e., 72 students) planned for in setting up the FY97 AN/WSC-3 class schedule. The model then calculates the proportionate cost of a distribution center's operation and personnel costs by multiplying the per student cost, by the number of students.

3.5.2.2.5 Duty Station Facilitator Time

Duty Station Facilitator Time is calculated in the Cost Model by multiplying the total time required of a facilitator, by the hourly rate of the facilitator.

A time estimate was made based on interviews performed during the Duty Station Implementation Analysis. With a high side for completion of the NRCBT version of the AN/WSC-3 course at 16 hours, and the optimum time for one sitting of two hours, it would take about eight days for a student to complete the course. Most Facilitators estimated their oversight time at less than 15 minutes per day of training. Receiving and returning the NRCBT course package was estimated at a total of one hour. Adding an additional hour for miscellaneous activities, the total time entered in the Cost Model was four hours ((8 days * 15 minutes each day) + 1 hour + 1 hour).

Based on interviews performed during the Duty Station Implementation Analysis, it became apparent that the assigned facilitator ranged from an ET Chief to an Electronic Technician Second Class (ET2). For purposes of the cost comparison, an hourly rate for an ET1 (i.e., $24.51) will be used in calculating the cost of the facilitator's time. The SPC Model was used to obtain the hourly rate for an ET1.

3.5.2.2.6 Student Materials

For purposes of this cost comparison, the combined cost to produce copies of the CD-ROM CBT courseware disk and the Student Guide were estimated by the R&DC analysts at $20.

3.5.2.3 Unobtainable Costs

3.5.2.3.1 Instructional Systems Development Process

R&DC analysts were unable to establish a cost for the Instructional Systems Development (ISD) Process. Therefore, assuming that similar costs would have to be incurred by both the ILRES and nonresident (e.g., interactive CBT, embedded training, correspondence) versions of the course, this cost was considered a "wash" between the ILRES and nonresident versions of the course. Therefore, the value entered in the Cost Model for this data point is zero ($0).

It should be noted that this data point would only be considered in the cost comparison analysis when there is a new training requirement. Under a scenario involving a new training requirement, the ILRES version of the course either does not exist or has to be modified.

4 COST MODEL RUNS AND ANALYSIS OF RESULTS

This section of the cost comparison report describes the various Cost Model runs, and presents an analysis of the results. Three sets of Cost Model runs were performed. The first set involved the subject of this report, determining the potential cost benefit of converting existing ILRES courses to NRCBT versions. Two scenarios were considered: conversion of a single ILRES course (Scenario One), and conversion of a "meaningful" number of existing ILRES courses (Scenario Two). The second set of runs were performed to determine the sensitivity of various factors in relation to Pay-back Period and Total Savings. Scenario Two, which involves the conversion of a "meaningful" number of existing ILRES courses, served as the basis for the sensitivity analysis. The third set of runs involved "what-if" scenarios based on Scenario Two. Those runs explored cost savings related to ILRES cost factors, Classroom & Lab Equipment and Classroom & Lab Space, if it were possible for the USCG to recover or avoid those costs.

4.1 GENERAL CONSIDERATION FOR COST MODEL RUNS

4.1.1 SUNK COSTS

Costs which are unaffected by a manager's decision are considered sunk costs. Deciding whether or not a cost should be treated as a sunk cost is dependent on the particular scenario being addressed by management. For example, replacing a substantial number of resident courses does not necessarily result in recouping the cost of existing building(s) in which the courses resided. To recoup those costs, the USCG would need to: sell the building(s) for at least the purchase price; lease the building(s) at a rate which would cover the cost of the building and its maintenance; or the building(s) would have to be used for an alternative purpose that served as a cost avoidance. Therefore, unless an opportunity to recoup the costs of the building(s) in some manner presents itself, the cost of the existing building(s) would have to be treated as a sunk cost, and would not be considered in the analysis.

4.2 COST COMPARISON MODEL RUNS

4.2.1 SINGLE COURSE CONVERSION (SCENARIO ONE)

4.2.1.1 Description of Model Run

Scenario One (1) is the replacement of a single existing ILRES course with a NRCBT version of that same course. Replacement of a single existing ILRES course will have little or no impact on a training center's operation and personnel budget requirements. Potential savings would be isolated to per student costs, which includes transportation, per diem, the cost of student time, and any consumable materials.

For the ILRES course, the following major costs are treated as sunk costs under Scenario One, and will therefore not be considered in this Cost Model run:

1. Classroom and lab space costs will be considered sunk costs. It is assumed in this Cost Model run that more than one ILRES course occupies the building where the replaced ILRES course once resided. Therefore, an opportunity to recover the value of the building does not exist.
2. Existing classroom and lab equipment costs will be considered sunk costs. It is assumed in this Cost Model run that an opportunity to recover the cost of existing equipment of the ILRES course does not exist. However, the cost for additional equipment (e.g., AN/WSC-3(v)7 UHF transceivers) based on annual student throughput will be considered.
3. Costs related to the development of an existing ILRES course (i.e., ISD Process, USCG SME Support) can only be considered in a scenario involving a new training requirement. Therefore, costs associated with course development will be considered as sunk costs.
4. As stated earlier, conversion of a single ILRES course will have little or no affect on a training center's operation and personnel requirements. Therefore, with one exception, costs associated with a training center's operations and staffing will be treated as sunk costs. The exception is the cost of additional instructors based on annual student throughput (refer to section 3.5.1.2.2 of this report for further explanation).

For the NRCBT course, since training center operations and personnel funding will not be affected, training center personnel previously associated with the ILRES course could be redirected to support, manage, and distribute the NRCBT course. Thus, the two NRCBT cost factors not considered in Scenario One are Student Support (e.g., Help Desk) and Distribution Center Operations & Personnel. They will be treated as sunk costs for this Cost Model run. Table 4-1 lists the cost values used in this Cost Model run. Costs that were unobtainable are entered as $0; and sunk costs are entered as "SUNK". Cost factors Training Center Operations & Personnel and Distribution Center Operations & Personnel are treated as O&M Costs in this model run, and therefore, a designation of "non-applicable" (N/A) has been given to these factors under Per Student Costs.

Table 4-1 Cost Factor Values Used in Cost Model Run for Scenario One

ILRES COURSE		NRCBT COURSE	
COST FACTOR	**COST**	**COST FACTOR**	**COST**
INVESTMENT		**INVESTMENT**	
ISD Process	$ 0.00	**ISD Process**	$ 0.00
USCG SME Support	SUNK	**CBT Design & Development**	$ 190,000.00
Classroom & Lab Space	SUNK	**USCG SME Support**	$ 43,017.40
Classroom & Lab Equipment		**Equipment for Course Distribution (72 students annually)**	$ 33,216.00
■ **Existing Equipment**	SUNK		
■ **Additional Equipment**	$ 0.00		
ANNUAL		**ANNUAL**	
TC Operations & Personnel	SUNK	**DC Operations & Personnel**	SUNK
Additional Instructors	$ 0.00	**CBT Courseware Maintenance**	$ 19,000.00
		Student Support	SUNK
Student Transportation	$ 500.00	**Duty Station Facilitator Time**	$ 98.04
TC Operations & Personnel	N/A	**DC Operations & Personnel**	N/A
Per Diem (M&IE)		**Shipping of Course Materials**	$ 72.00
■ **Training Center**	$ 44.00		
■ **Travel Days**	$ 48.00		

4.2.1.2 Result Of Cost Model Run

Based on an Annual Student Throughput Rate of 72 students, this Cost Model run calculated the Pay-back Period (Break-even Point) at 5.31 years (5 years and 4 months). With a consistent Annual Student Throughput Rate of 72 students over the projected course life-span of seven years, Total Savings from operation of the NRCBT version of the course would be $84,712. Table 4-2 presents the total costs over the seven-year period for both the ILRES and NRCBT versions of the course, broken out by Cost Category, and the cost difference between the two versions of the course (NRCBT Savings). Elimination of the need to transport students to a training site ("travel-free" training), and a decrease in student time to complete the course from 40 to 13 hours, are the two major contributing factors to the cost difference between NRCBT and ILRES. Student Transportation accounts for $252K (36 percent) of the total cost to operate the ILRES version of the course over the seven-year period. The decrease in student time, from 40 hours for the resident course to 13 hours for the NRCBT course, results in a cost difference of $248K. If student travel requirements were not eliminated, or the time to complete the NRCBT version of the course were to rise above 22 hours, the result would be a loss to the USCG. No other single ILRES cost factor in Scenario One, by itself, can cause Total Savings to decrease by an amount that would result in a loss.

Table 4-2 Comparison of Costs for Scenario One

TOTAL COSTS OVER LIFE OF COURSE (7 YEARS) BASED ON ANNUAL STUDENT THROUHPUT OF 72 STUDENTS			
	TOTAL ILRES COSTS	TOTAL NRCBT COSTS	NRCBT SAVINGS
INVESTMENT	$ 0.00	$ 266,233.40	($ 266,233.40)
ANNUAL	$ 0.00	$ 133,000.00	($ 133,000.00)
STUDENT	$ 699,300.00	$ 215,354.16	$ 483,945.84
TOTAL	**$ 699,300.00**	**$ 614,587.56**	**$ 84,712.44**

It is also important to note that the decrease in student time results in a total time savings of 1,944 hours per year, and 13,608 hours over a seven-year period. If facilitator time for the NRCBT version of the course (2,016 hours over the seven-year period) were to be deducted from the total student time saved, it would still result in a total time savings of 11,592 hours. The time saved by operation of the NRCBT version of the course could be redirected to operational unit needs.

Figure 4-1 compares, for Scenario One, the operation costs of the NRCBT version of the course over the Course Life-span, with the ILRES version of the same course. As demonstrated by the graph, until the Pay-back Period is reached, the costs of the NRCBT version of the course exceeds those of the ILRES version. If an unexpected event were to occur which eliminated the need for the course in the USCG before the Pay-back Period is reached, the result of the investment in the NRCBT version of the course would be a loss, rather than a savings.

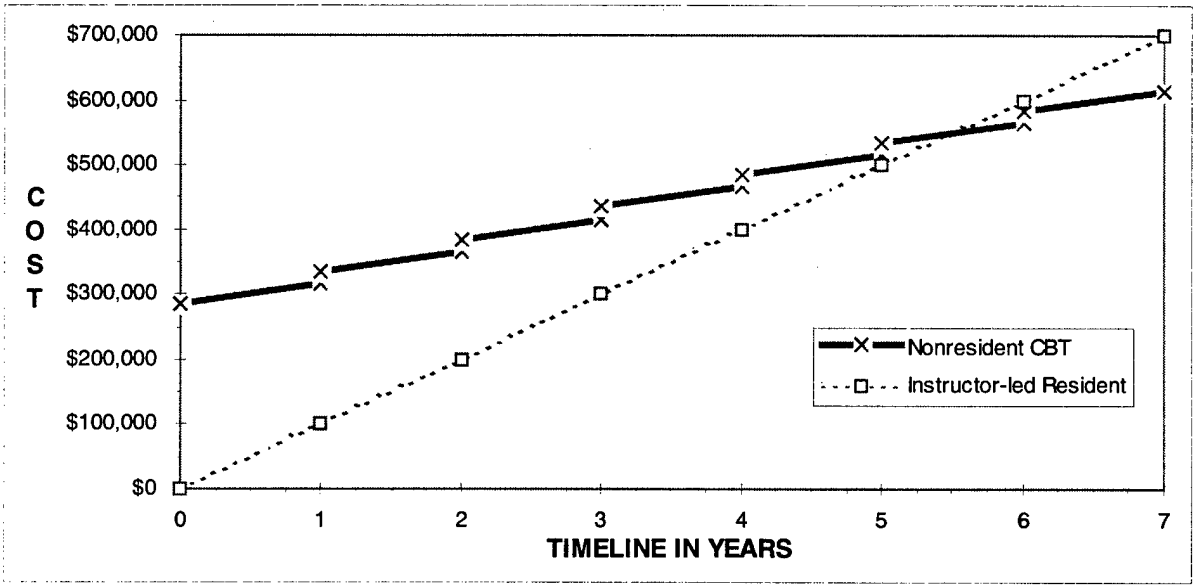

Figure 4-1 Comparison of NRCBT and ILRES Costs for Scenario One

Infrastructure costs to support implementation of a single NRCBT course at the student's duty station will be extremely small, and easily absorbed at the unit level. This statement is based on what was learned in performing the Duty Station Implementation Analysis. Infrastructure costs for operation of the single NRCBT course, such as, computer hardware and duty station facilitator time, are accounted for in the cost considerations used for Scenario One.

4.2.2 MULTIPLE COURSE CONVERSIONS (SCENARIO TWO)

4.2.2.1 Description of Model Run

Scenario Two is the replacement of a "meaningful" number of ILRES courses across the USCG training program, which are converted to a non-resident (e.g., interactive CBT, embedded training, and correspondence) version. This allows for re-organization of the USCG training structure to save approximately the proportion of training center costs shared by each course conversion. Therefore, all costs associated with the operation and staffing of a training center will be considered in Cost Model runs for Scenario Two. Assume all courses converted are similar to the AN/WSC-3 course only for basis of ILRES versus NRCBT cost comparison of multiple course conversions.

For this run of the Cost Model, the following ILRES costs are considered sunk costs:

1. Classroom and lab space costs will be considered sunk costs. It is assumed, for this Cost Model run, that there will be no opportunity for the USCG to recover the value of building(s).
2. Existing classroom and lab equipment costs will be considered sunk costs. It is assumed for this Cost Model run that there will be no opportunity for the USCG to recover the value of the existing equipment. However, the cost for any additional equipment (e.g., AN/WSC-3(v)7 UHF transceivers) requirements based on annual student throughput will be considered.

Table 4-3 lists the cost values used in this Cost Model run. Costs that were unobtainable are entered as $0, and sunk costs are entered as "SUNK". Cost factors, Training Center Operations & Personnel and Distribution Center Operations & Personnel, are treated as O&M Costs in this model run, and therefore, a designation of "non-applicable" (N/A) has been given to these factors under Per Student Costs.

Table 4-3 Cost Factor Values Used in Cost Model Run for Scenario Two

ILRES COURSE		NRCBT COURSE	
COST FACTOR	**COST**	**COST FACTOR**	**COST**
INVESTMENT		**INVESTMENT**	
ISD Process	$ 0.00	**ISD Process**	$ 0.00
USCG SME Support	SUNK	**CBT Design & Development**	$ 190,000.00
Classroom & Lab Space	SUNK	**USCG SME Support**	$ 43,017.40
Classroom & Lab Equipment		**Equipment for**	
■ **Existing Equipment**	SUNK	**Course Distribution**	
■ **Additional Equipment**	$ 0.00	**(72 students annually)**	$ 33,216.00
ANNUAL		**ANNUAL**	
Training Center Operations & Personnel	$ 150,206.40	**DC Operations & Personnel**	$ 5,282.64
Additional Instructors	$ 0.00	**CBT Courseware Maintenance**	$ 19,000.00
		Student Support	$ 50,976.00
PER STUDENT		**PER STUDENT**	
Student Time	$ 730.00	**Student Time**	$ 237.25
Student Materials	$ 65.00	**Student Materials**	$ 20.00
Student Transportation	$ 500.00	**Duty Station Facilitator Time**	$ 98.04
Training Center Operations & Personnel	N/A	**DC Operations & Personnel**	N/A
Per Diem (M&IE)		**Shipping of Course Materials**	$ 72.00
■ **Training Center**	$ 44.00		
■ **Travel Days**	$ 48.00		

4.2.2.2 Result Of Cost Model Run

Based on an Annual Student Throughput Rate of 72 students, the Cost Model run calculated the Pay-back Period (Break-even Point) at 1.85 years (1 year and 11 months). With a consistent Annual Student Throughput Rate of 72 students over the projected Course Life-span of seven years, Total Savings from operation of the NRCBT version of the course would be $742,347.

When comparing the Total Savings of Scenario Two with that of Scenario One, Total Savings increased by $675,634 in Scenario Two, or 876 percent. When reviewing cost differences between operation of the ILRES and NRCBT versions of the course for Scenario Two, which are presented in Table 4-4, elimination of ILRES O&M Costs would have the largest impact on Total Savings. The single cost factor that makes up ILRES O&M Costs in Scenario Two is Training Center Operations & Personnel. Training Center Operations & Personnel accounts for 60 percent of the total cost to operate the ILRES course in Scenario Two. To further demonstrate the difference that the Training Center Operations & Personnel cost factor makes in the cost comparison analysis for Scenario Two, when considering savings from the difference in O&M Costs alone (ILRES O&M Costs - NRCBT O&M Costs), the resulting Pay-back Period is 3.55 years (NRCBT Investment Cost of $266,233, divided by O&M Cost Savings of $74,947).

Table 4-4 Comparison of Costs for Scenario Two

TOTAL COSTS OVER LIFE OF COURSE (7 YEARS) BASED ON ANNUAL STUDENT THROUHPUT OF 72 STUDENTS			
	TOTAL ILRES COSTS	TOTAL NRCBT COSTS	NRCBT SAVINGS
INVESTMENT	$ 0.00	$ 266,233.40	($ 266,233.40)
ANNUAL	$ 1,051,444.80	$ 526,810.48	$ 524,634.32
STUDENT	$ 699,300.00	$ 215,354.16	$ 483,945.84
TOTAL	**$ 1,750,744.80**	**$ 1,008,398.04**	**$ 742,346.76**

This increase in Total Savings is important, as implementation of more than one nonresident course (e.g., interactive CBT, embedded training, and correspondence) at the duty station will have an impact on the USCG's current infrastructure. For example, implementation of multiple nonresident courses at the duty station might result in added costs to operational unit overhead (e.g., administration time). The costs of that impact, and other costs related to the training infrastructure required to support nonresident training, can be offset by reinvestment of some percentage of these savings.

Figure 4-2 compares, for Scenario Two, the operation costs of the NRCBT version of the course over the Course Life-span, with the ILRES version of the same course. Operation of the NRCBT course beyond the Pay-back Period will result in savings, which can be redirected as management sees fit. The amount of savings beyond the Pay-back Period is represented in Figure 4.2 by the space between the line representing the cost of operating the ILRES course, and the line representing the cost of operating the NRCBT version of the course.

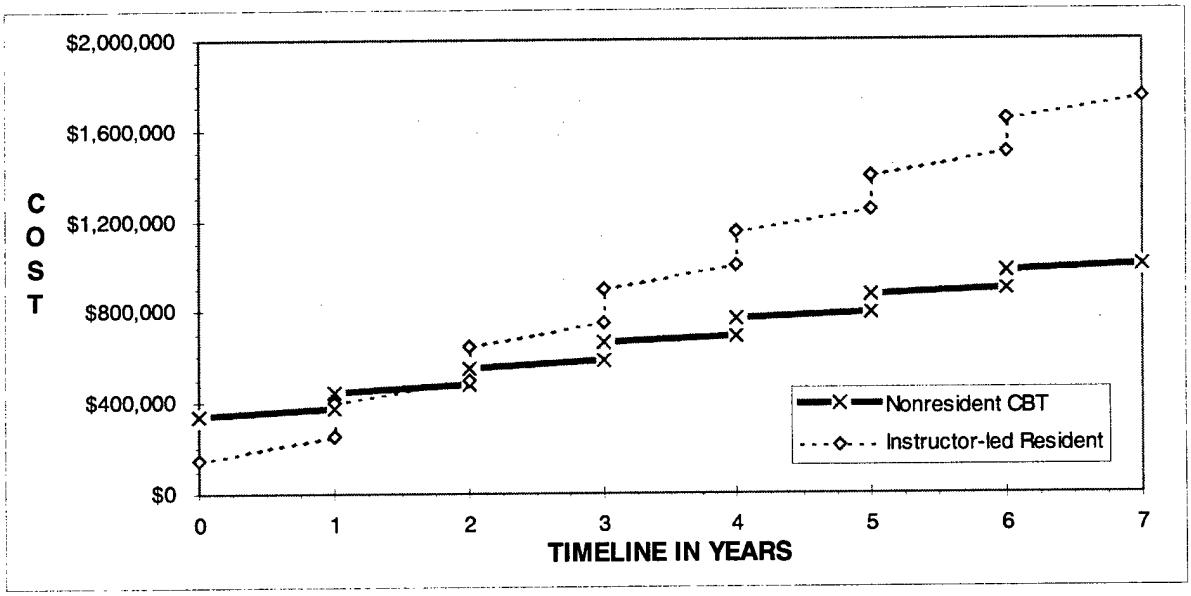

Figure 4-2 Comparison of ILRES and NRCBT Costs for Scenario Two

4.3 SENSIVITY ANALYSIS MODEL RUNS

The Cost Model is only an approximation of reality (Render & Stair, Jr., 1988). Therefore, exploring the sensitivity of the solution (Pay-back Period and Total Savings) to changes in input data was an important part of analyzing the results. A sensitivity analysis was performed to determine how much Pay-back Period and Total Savings would change, if there were changes to the input data. A sensitivity analysis was performed for a select group of factors considered in the Cost Model. Since Scenario Two is relevant to the goal of the USCG, which is to convert enough ILRES courses to an equivalent, nonresident version (e.g., interactive CBT, embedded training, correspondence), that would result in a maximum savings of training dollars, Scenario Two served as the basis for the sensitivity analysis. For each sensitivity analysis performed, only one factor (parameter) was changed, while the other factors remained equivalent to the values used for Scenario Two. The results of the sensitivity analysis are summarized in this subsection of the report. Detailed graphs for each sensitivity analysis performed are presented in Appendix C.

This subsection has been divided into three parts. The first part of this explores the sensitivity of two non-cost factors considered in the cost comparison. The second part of this subsection explores the sensitivity of 13 cost factors considered in the cost comparison. The third part of this subsection compares the treatment of the ILRES Training Center Operations & Personnel cost factor, as both an O&M Cost, and a Per Student Cost.

4.3.1 NON-COST FACTORS

A sensitivity analysis was performed for two non-cost factors, Annual Student Throughput Rate and Course Life-span. A third non-cost factor, Course Length, was not considered in the sensitivity analysis. In the Cost Model, Course Length is treated as the length of time required by a student to complete the ILRES version of the course (i.e., 5 days). Since changing the amount of time required for a student to complete the ILRES version of the course was not an option, there was no need to perform a sensitivity analysis of this data point.

4.3.1.1 Annual Student Throughput Rate

Figures 4-3(a) and 4-3(b) show the affect on Pay-back Period and Total Savings, respectively, as the Annual Student Throughput Rate changes in Scenario Two. In reviewing these two figures, Total Savings (Figure 4-3(b)) displays a higher sensitivity to changes in the Annual Student Throughput Rate, as opposed to Pay-back Period (Figure 4-3(a)). The change in Pay-back Period between an Annual Student Throughput Rate of 36 students, and 180 students, is 54 percent (1.24 years divided by 2.28 years), or a difference of just over 1 year. In comparison, the change in Total Savings between Annual Student Throughput Rates of 36 and 180 students is 276 percent ($1,426,746 divided by $516,982), or a difference of $909,764.

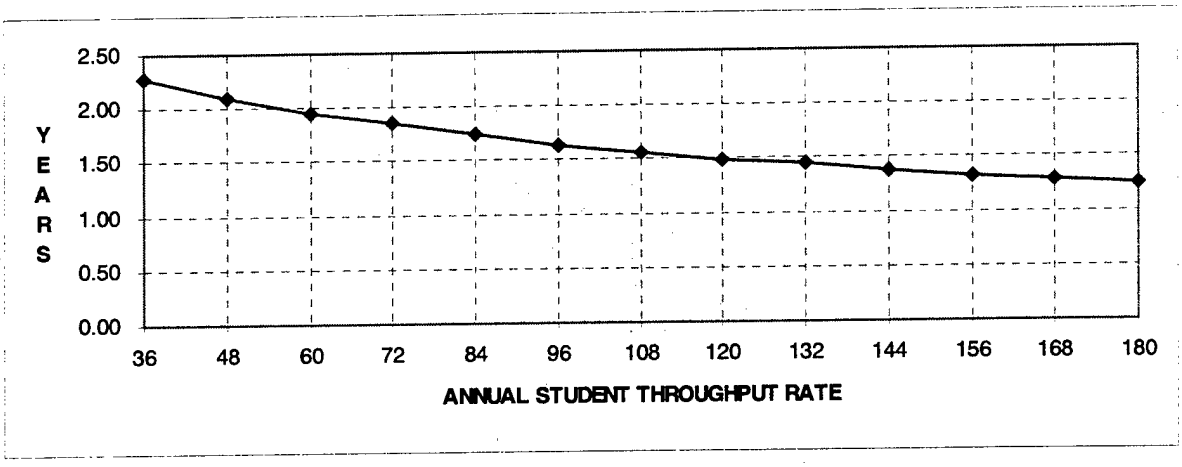

Figure 4-3(a) Sensitivity of Pay-back Period to Changes in Annual Student Throughput Rate

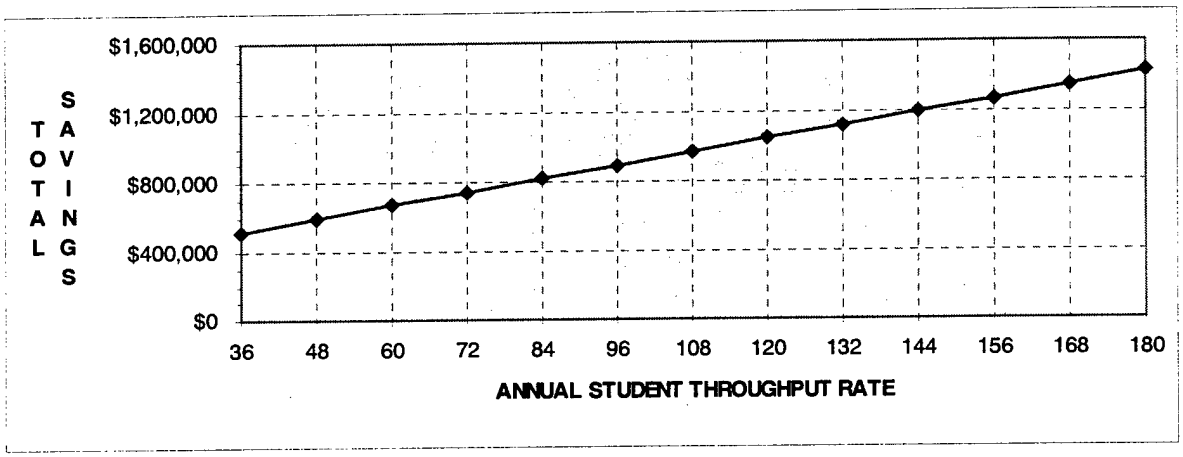

Figure 4-3(b) Sensitivity of Total Savings to Changes in Annual Student Throughput Rate

The greater sensitivity of Total Savings is attributable to the Annual Student Throughput Rate's direct affect on Annual Student Costs (Annual Student Throughput Rate * Per Student Costs). Table 4-5 shows Annual Student Costs incurred each year for Scenario Two, based on three different rates of annual student throughput. The cost difference between the ILRES and NRCBT versions results in the NRCBT Student Savings, relative to Per Student Costs. As the Annual Student Throughput Rate increases, the amount of NRCBT savings from Per Student Costs, which can be used to offset the difference in O&M Costs (ILRES O&M Costs - NRCBT O&M Costs), increases.

Table 4-5 Difference in Annual Student Costs (NRCBT Savings)

ANNUAL STUDENT THROUGHPUT RATE	ILRES STUDENT COST	NRCBT STUDENT COST	NRCBT STUDENT SAVINGS
36	$ 49,950	$ 15,382	$ 34,568
72	$ 99,900	$ 30,764	$ 69,136
108	$ 149,850	$ 46,147	$ 103,703

Any savings that remains after O&M Costs have been covered, can then be applied toward the NRCBT Investment Cost. In the case of Scenario Two, the cost difference between ILRES O&M Costs and NRCBT O&M Costs favors the NRCBT course for the three levels of Annual Student Throughput Rate presented in Table 4-5. Therefore, a greater amount of savings each year can be applied against the NRCBT Investment Cost. Table 4-6 presents NRCBT Annual Savings, which can be applied each year of operation toward the NRCBT Investment Cost. Once all NRCBT Investment Costs have been recovered (Pay-back Period is reached), the savings generated from that point on can be considered pure profit (dollar savings to the USCG training program).

Table 4-6 Difference in Annual Costs (NRCBT Annual Savings)

ANNUAL STUDENT THROUGHPUT RATE	NRCBT SAVINGS (ANNUAL STUDENT COSTS)	NRCBT SAVINGS (O&M COSTS)	NRCBT ANNUAL SAVINGS
36	$ 34,568	$ 74,947	$ 109,515
72	$ 69,136	$ 74,947	$ 144,083
108	$ 103,703	$ 74,947	$ 178,650

Although Total Savings is sensitive to changes in the Annual Student Throughput Rate, even for the most pessimistic situation under Scenario Two, there is still an acceptable Pay-back Period and a positive Total Savings. With an Annual Student Throughput Rate for Scenario Two of zero students, the Pay-back Period is 3.11 years, and there's a Total Savings of $291,617 over the seven-year Course Life-span. The reason for this insulation of Scenario Two, to such a dramatic decrease in the Annual Student Throughput Rate, is the ILRES Training Center Operations & Personnel cost factor. Without a single student taking the NRCBT course, O&M Cost savings (ILRES O&M Costs - NRCBT O&M Costs) as a result of choosing the NRCBT version of the course in Scenario Two, saves $74,947 a year. Consideration of the single cost factor, Training Center Operations & Personnel, serves to insulate Scenario Two from a dramatic decrease in the Annual Student Throughput Rate, which could otherwise result in a loss, rather than a savings.

Compare the insulation of Scenario Two to dramatic decreases in the Annual Student Throughput Rate, to that of Scenario One. Recall that Scenario One is the replacement of a single, existing ILRES course, with an equivalent NRCBT version of that course. Replacement

of a single course will not affect the costs associated with the operation and staffing of a training center. Therefore, the Training Center Operations & Personnel cost factor is designated as a sunk cost for Scenario One. A drop below an Annual Student Throughput Rate of 59 students (Figure 4-4) would result in a loss over the projected Course Life-span (seven-years). For that reason, a single, existing ILRES course, with a low Annual Student Throughput Rate, is a suspect candidate for replacement by an NRCBT version. Especially if that NRCBT version must be designed and developed from scratch, versus an off-the-shelf version of the CBT courseware. The most preferable situation is going to be the replacement of a "meaningful" number of courses as represented by Scenario Two, which allows for re-organization of the USCG training structure to save approximately the proportion of training center costs shared by each course conversion. As shown previously, an Annual Student Throughput Rate of zero students still results in a positive Total Savings for Scenario Two. Therefore, it could be stated theoretically that consideration of costs associated with the operation and staffing of a training center could eliminate Annual Student Throughput Rate as a factor when concerned exclusively with gains versus losses. It is also important to note that increased savings resulting from Scenario Two may provide the funds required to offset the cost of developing and deploying an infrastructure to support NRCBT, and still provide the USCG with the desired savings level (Total Savings - Infrastructure Costs), or Rate-of-Return.

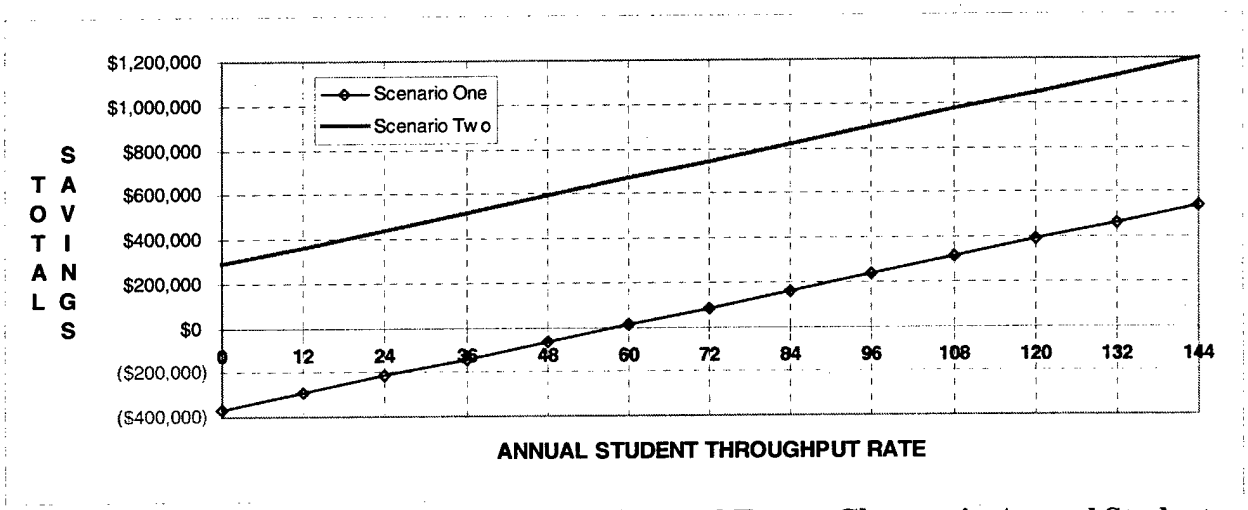

Figure 4-4 Comparing Sensitivity of Scenario One and Two to Changes in Annual Student Throughput Rate

4.3.1.2 Course Life-span

By definition, changes in Course Life-span will not have any affect on Pay-back Period. Pay-back Period is calculated as Investment Costs, divided by NRCBT Annual Savings. Course Life-span is not a part of that calculation. However, Course Life-span has a large impact on Total Savings. Total Savings is calculated as ((Course Life-span * NRCBT Annual Savings) - Investment Costs). As Course Life-span is decreased, Total Savings is decreased. If the Course Life-span were to fall below the calculated Pay-back Period, the result would be a loss, rather

than a savings. The affect on Total Savings by a percentage change in Course Life-span is presented in Figure 4-5.

The potential for a loss, rather than a gain, is the reason Cost Analysts prefer a short (conservative) Pay-back Period in relation to the projected (estimated) Course Life-span. The further into the future the Pay-back Period is extended, the greater the risk there will be an unexpected event that either shortens the usefulness of the course to the organization, or decreases the predicted Annual Student Throughput Rate. Based on the Pay-back Period calculated for Scenario Two (1.85 years), a 50 percent decrease in the Course Life-span, from seven years to 3.5 years, will still result a Course Life-span that is greater than Pay-back Period for Scenario Two. Although a 50 percent decrease in Course Life-Span (represented in Figure 4-5 as 50 percent of base value) would lessen Total Savings by approximately $500K, Scenario Two would still result in a savings, rather than a loss.

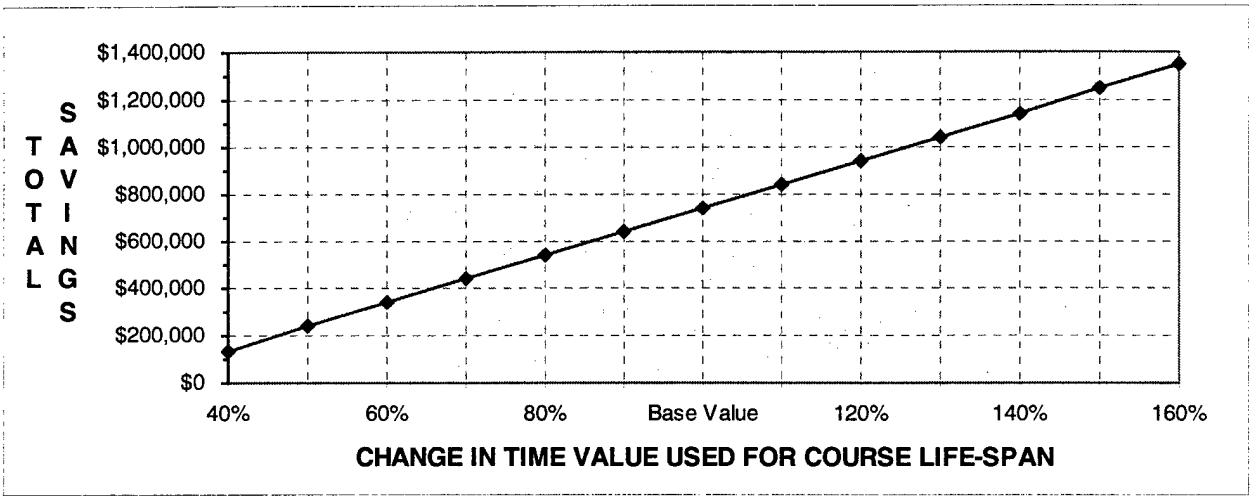

Figure 4-5 Sensitivity of Total Savings to Changes in Course Life-span

In the past, course life-spans of seven years or greater have been typical in the USCG training program. Course life-span being the period of time between implementation of the course in the USCG (in any form), to the course being completely eliminated from the USCG training program. The life-span of a course is dependent on the useful-life to the USCG of the system or piece of equipment being trained.

4.3.2 COST FACTORS

This part of the Sensitivity Analysis explores the sensitivity of Pay-back Period and Total Savings to percentage changes in the values of a select group of cost factors. Tables 4-7(a) and 4-7(b), respectively, present a list of NRCBT and ILRES cost factors for which a sensitivity analysis was performed. For each cost factor explored, the associated table indicates the precise parameter changed, and the value used for that parameter in the Cost Model run for Scenario Two.

Table 4-7(a) NRCBT Cost Factors Considered in Sensitivity Analysis

COST FACTOR	PARAMETER	PARAMETER VALUE
Investment Costs		
CBT Design & Development	Cost Per CBT Instructional Hour	$ 19,000.00
USCG SME Support	Total SME Support Cost	$ 43,017.40
Equipment for Course Distribution	Per Unit Cost (i.e., computer laptop and shipping case)	$ 4,152.00
O&M Costs		
DC Operations & Personnel	Total Operations and Personnel Costs	$ 5,282.64
Courseware Maintenance	Percentage	10 %
Student Support	Total Student Support Costs	$ 50,976.000
Per Student Costs		
Student Time	Time to Complete Course	13 Hours
Duty Station Facilitator Time	Time of Facilitator	4 Hours
Shipping of Course Materials	Total Shipping Costs	$ 72.00
Student Materials	Total Materials Cost	$ 20.00

Table 4-7(b) ILRES Cost Factors Considered in Sensitivity Analysis

COST FACTOR	PARAMETER	PARAMETER VALUE
O&M Costs		
TC Operations & Personnel	Total Operations and Personnel Costs	$ 150,206.40
Per Student Costs		
Student Materials	Total Materials Cost	$ 65.50
Student Transportation	Total Transportation Costs	$ 500.00

Cost factors which were not explored for sensitivity are ISD Process (ILRES and NRCBT), USCG SME Support (ILRES), Student Time (ILRES), and Per Diem (ILRES). As stated earlier in this report, the R&DC analysts were unable to establish a cost for the ISD Process based on the information received. As a result, there was no basis to perform the sensitivity analysis for the ISD Process. It is also important to note that Scenario Two involves conversion of an existing ILRES course. Therefore, costs associated with development of the existing ILRES course, such as the ILRES cost factors, ISD Process and USCG SME Support, must be treated as sunk costs. As with the ILRES ISD Process cost factor, the NRCBT ISD Process cost factor will only be considered when an existing version of the ILRES course does not exist, or needs to be modified as the result of a new training requirement.

The two ILRES cost factors, Student Time and Per Diem, are based on published information by the USCG. Therefore, the values used for these cost factors are considered highly accurate.

Table 4-8(a) presents the results of the sensitivity analysis for Pay-back Period, based on several levels of percentage changes (ranging from a 60% decrease in the base value, to a 60% increase in the base value) in the corresponding cost factor value. Approximately every five (5) percentage points in Table 4-8(a) represents a one-month change in Pay-back Period. Therefore, an increase of five percentage points in Pay-back Period would equate to a Pay-back Period of two years (1 year and 11 months for Scenario Two, plus one month as the result of the 5 percent increase).

Table 4-8(b) presents the results of the sensitivity analysis for Total Savings, based on similar levels of percentage changes in the corresponding cost factor. A five (5) percent change in Total Savings represents a $37K (rounded) change in Total Savings calculated for Scenario Two ($742K). A five percent decrease in Total Savings ($742K - $37K), equates to a Total Savings of $705K.

Table 4-8(a) Results of Sensitivity Analysis for Pay-Back Period (Scenario Two)

Cost Factor	Cost Type	Percentage Decrease			Percentage Increase		
		60%	40%	20%	20%	40%	60%
Investment Costs							
CBT Design & Development	NRCBT	43%	29%	14%	14%	29%	43%
USCG SME Support	NRCBT	10%	6%	3%	3%	6%	10%
Equipment for Course Distribution	NRCBT	7%	5%	2%	2%	5%	7%
O&M Costs							
Training Center Operations & Personnel	ILRES	167%	72%	26%	17%	29%	38%
Distribution Center Operations & Personnel	NRCBT	2%	1%	1%	1%	1%	2%
Courseware Maintenance	NRCBT	7%	5%	3%	3%	6%	9%
Student Support	NRCBT	18%	12%	7%	8%	16%	27%
Per Student Costs							
Student Time	NRCBT	7%	5%	2%	2%	5%	8%
DS Facilitator Time	NRCBT	3%	2%	1%	1%	2%	3%
Shipping of Course Materials	NRCBT	2%	1%	1%	1%	1%	2%
Student Materials	NRCBT	1%	1%	0%	0%	1%	1%
Student Materials	ILRES	2%	1%	1%	1%	1%	2%
Student Transportation	ILRES	18%	11%	5%	5%	9%	13%

Table 4-8(b) Results of Sensitivity Analysis for Total Savings (Scenario Two)

Cost Factor	Cost Type	Percentage Decrease			Percentage Increase		
		60%	40%	20%	20%	40%	60%
Investment Costs							
CBT Design & Development	NRCBT	15%	10%	5%	5%	10%	15%
USCG SME Support	NRCBT	3%	2%	1%	1%	2%	3%
Equipment for Course Distribution	NRCBT	3%	2%	1%	1%	2%	3%
O&M Costs							
TC Operations & Personnel	ILRES	85%	57%	28%	28%	57%	85%
DC Operations & Personnel	NRCBT	3%	2%	1%	1%	2%	3%
Courseware Maintenance	NRCBT	11%	7%	4%	4%	7%	11%
Student Support	NRCBT	29%	19%	10%	10%	19%	29%
Per Student Costs							
Student Time	NRCBT	10%	6%	3%	3%	6%	10%
DS Facilitator Time	NRCBT	4%	3%	1%	1%	3%	4%
Shipping Of Course Materials	NRCBT	3%	2%	1%	1%	2%	3%
Student Materials	NRCBT	1%	0%	0%	0%	0%	1%
Student Materials	ILRES	3%	2%	1%	1%	2%	3%
Student Transportation	ILRES	20%	14%	7%	7%	14%	20%

Figures 4-6(a) and 4-6(b) present tornado diagrams which give a visual perspective of the sensitivity of Pay-back Period and Total Savings, respectively, to percentage changes in the corresponding cost factor's base value. Pay-back Period is presented in terms of years, and Total Savings is presented in terms of thousands-of-dollars ($K). It is important to note, when reviewing the two figures, that an increase in the base value of an NRCBT cost factor would be considered a pessimistic change to the cost factor, as the effect of that change causes Total Savings to decline and Pay-back Period to increase. A decrease in the base value of an ILRES cost factor would be considered a pessimistic change to the cost factor as Total Savings would decline, and Pay-back Period would increase.

A discussion of the sensitivity analysis results, which are presented in Tables 4-8(a) and 4-8(b), and again, in Figures 4-6(a) and 4-6(b), follows. For purposes of this discussion, the results for each cost factor considered in the sensitivity analysis will be categorized by a rating of high sensitivity, moderate sensitivity, or low sensitivity. The threshold for each sensitivity category, which is presented in Table 4-9, was arbitrarily determined by the R&DC analyst. For example, a Pay-back Period sensitivity which is greater than, or equal to, 27 percent, will be considered to have a high sensitivity rating. The discussion will address sensitivity of each cost factor considered in the sensitivity analysis, based on the highest of the two sensitivity ratings (Pay-back Period and Total Savings) for a 40 percent change in the value of the cost factor (Table 4-10).

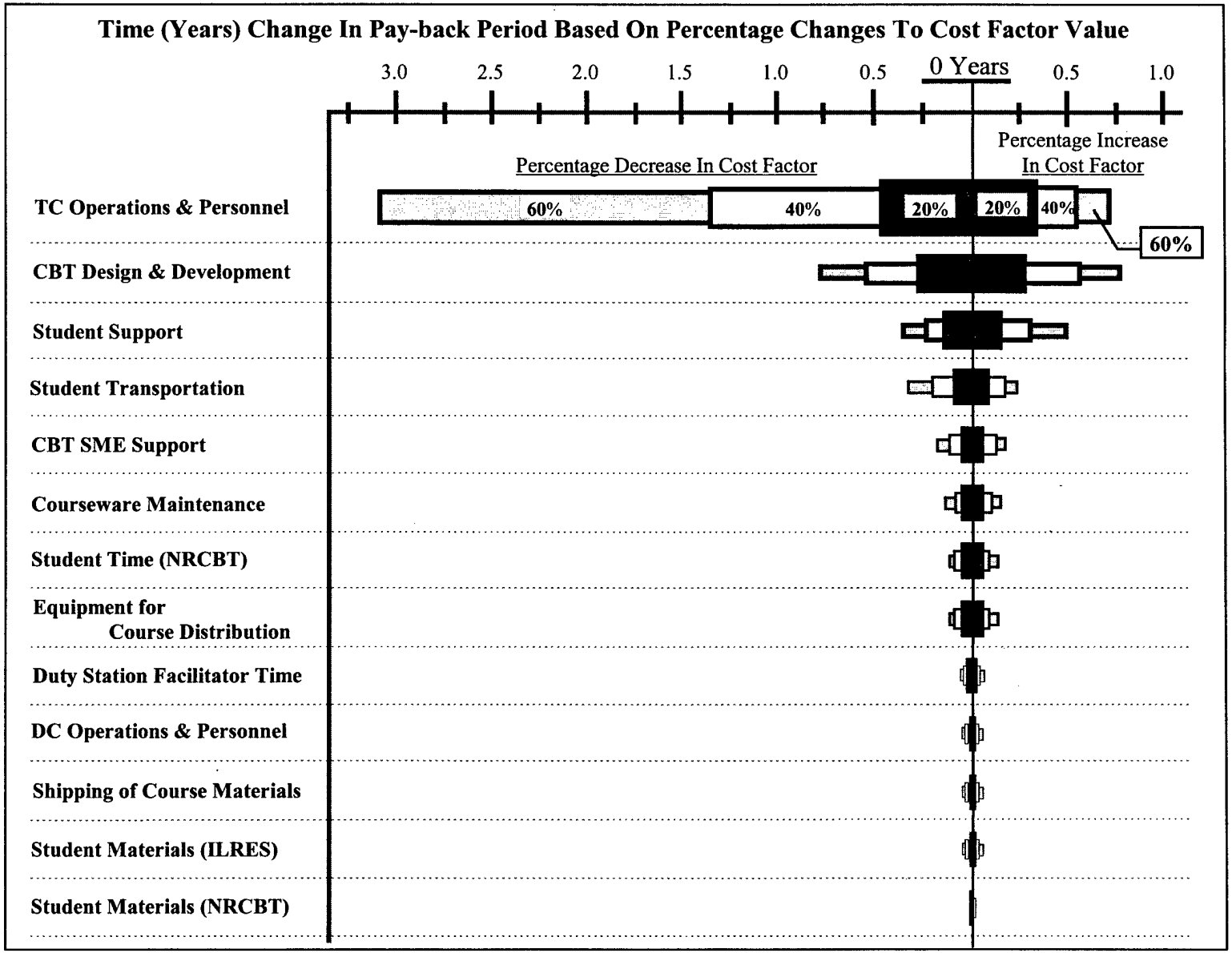

Figure 4-6(a) Tornado Diagram Presenting Sensitivity of Pay-back Period to Changes in Corresponding Cost Factors

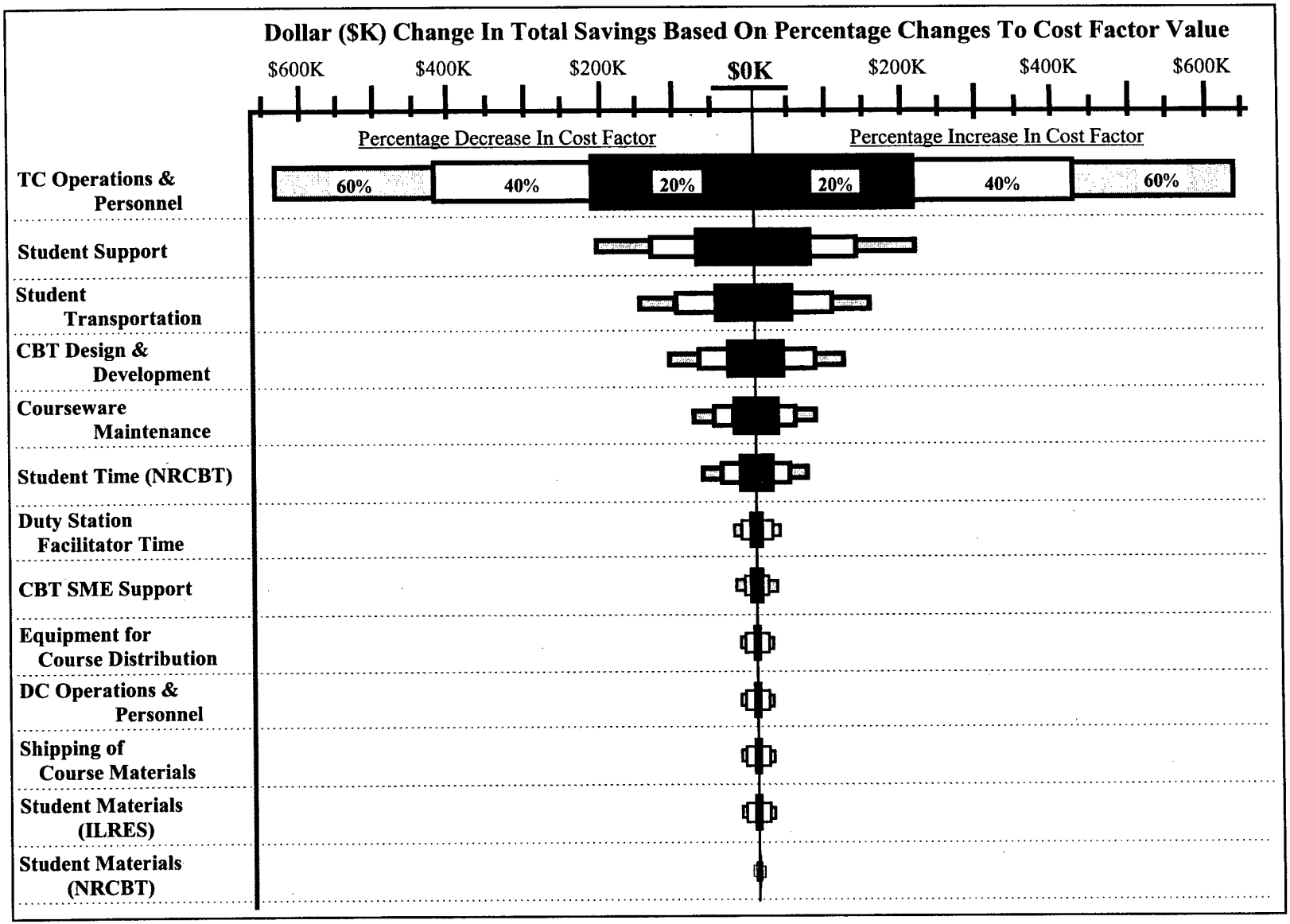

Figure 4-6(b) Tornado Diagram Presenting Sensitivity of Total Savings to Changes in Corresponding Cost Factors

Table 4-9 Sensitivity Category Thresholds

	PAY-BACK PERIOD		TOTAL SAVINGS	
	Sensitivity Rating	Time	Sensitivity Rating	Dollars
HIGH	27 %	6 months	15 %	$ 111,352
MODERATE	14 %	3 months	5 %	$ 37,117
LOW	0 %	0 month	0 %	$ 0

Table 4-10 Sensitivity Category in which each Cost Factor Considered will be Addressed

COST FACTOR	COST TYPE	PAY-BACK PERIOD	TOTAL SAVINGS	ADDRESSED IN DISCUSSION AS
Investment Costs				
CBT Design & Development	NRCBT	High	Moderate	High
USCG SME Support	NRCBT	Low	Low	Low
Equipment for Course Distribution	NRCBT	Low	Low	Low
O&M Costs				
TC Operations & Personnel	ILRES	High	High	High
DC Operations & Personnel	NRCBT	Low	Low	Low
Courseware Maintenance	NRCBT	Low	Moderate	Moderate
Student Support	NRCBT	Moderate	High	High
Per Student Costs				
Student Time	NRCBT	Low	Moderate	Moderate
DS Facilitator Time	NRCBT	Low	Low	Low
Shipping of Course Materials	NRCBT	Low	Low	Low
Student Materials	NRCBT	Low	Low	Low
Student Materials	ILRES	Low	Low	Low
Student Transportation	ILRES	Low	Moderate	Moderate

4.3.2.1 High Sensitivity

Three cost factors are deemed to have high sensitivity ratings; Training Center Operations & Personnel (ILRES cost factor), CBT Design & Development (NRCBT cost factor), and Student Support (NRCBT cost factor).

4.3.2.1.1 Training Center Operations & Personnel

As shown in Figures 4-6(a) and 4-6(b), the changes in the base (cost) value used for Training Center Operations & Personnel resulted in the highest sensitivity rates among all cost factors considered in the sensitivity analysis, for both Pay-back Period and Total Savings. The high sensitivity rates are attributable to the large percentage of costs to operate an ILRES course each year (O&M Costs + Total Annual Student Costs). This rate is made up by the Training Center Operations & Personnel cost factor, and in turn, its large percentage contribution to NRCBT Annual Savings realized from operation of the NRCBT course.

To understand the high impact Training Center Operations & Personnel has on the outcome of Scenario Two (Annual Student Throughput Rate of 72 students), the reader must understand the scale of this cost, in comparison to all other costs considered in the Cost Model run for Scenario Two. Based on the cost data used for Scenario Two, costs to operate and staff a training center makes up 60 percent of the total cost (O&M Costs + Annual Student Costs) to operate the ILRES course each year. When the cost value for Training Center Operations & Personnel, alone, is compared to the total O&M Costs required to operate the NRCBT version of the course each year, an NRCBT Annual Savings of $74,948 is realized as the result of operating NRCBT version of the course. That savings of $74K makes up 52 percent of the NRCBT Annual Savings each year. Even more impressive is the fact that choosing the NRCBT version results in a Pay-back Period of 3.55 years (Figure 4-7). Therefore, consideration of the ILRES cost factor, in any cost comparison analysis effort, will have a large impact on the results.

NRCBT Investment Cost		
CBT Design & Development	$ 190,000	
USCG SME Support	43,017	
Equipment for Course Distribution	33,216	
Total NRCBT Investment Cost	**$ 266,233**	
Savings from Difference In Annual Costs		
ILRES Annual Cost		
Training Center Operations & Personnel	$ 150,206	
Additional Instructors	0	
Total ILRES Annual Cost	**$ 150,206**	**$ 150,206**
NRCBT Annual Cost		
CBT Maintenance	$ 19,000	
Student Support	50,976	
Distribution Center Operation & Personnel	5,282	
Total NRCBT Annual Cost	$ 75,258	75,258
Annual Cost Savings		$ 74,948

$ 266,233 divided by $ 74,948 = **3.55 year Pay-back Period**

Figure 4-7 Calculating Pay-back Period, Excluding Per Student Savings

As the results in Table 4-8(b) and Figure 4-6(b) show, a 40 percent decrease in the base value of the Training Center Operations & Personnel cost factor results in a significant drop in Total Savings over the Course Life-span. Total Savings drops from $742K for Scenario Two, to $321K, a drop of $400K. However, even with a very pessimistic 60 percent decrease in the base value for Training Center Operations & Personnel, which results in a Total Savings of $111K (Table 4-11), is greater than Total Savings of $85K for Scenario One. Total Savings relative to the value used for Training Center Operations & Personnel, does not drop below Total Savings for Scenario One until costs to operate and staff a training center are cut by more than 70 percent.

Table 4-11 Percentage Change in TC Operations & Personnel Costs

Annual Cost of Training Center Operations & Personnel	Percentage Change	Pay-back Period	Total Savings
$ 60,082	- 60%	4.93	$ 111,480
$ 90,123	- 40%	3.17	$ 321,769
$ 120,165	- 20%	2.33	$ 532,058
$ 150,206	0%	1.85	$ 742,347
$ 180,206	+ 20%	1.53	$ 952,636
$ 210,288	+ 40%	1.30	$ 1,162,925
$ 240,330	+ 60%	1.14	$ 1,373,214

Pay-back Period increases to 3.17 years (3 years and 3 months) when Training Center Operations & Personnel costs are cut by 40 percent. When considering that the risk of any investment is closely tied to Pay-back Period in relation to the life-span of the investment, the high sensitivity of Pay-back Period, to changes in the base value used for the Training Center Operations & Personnel cost factor, makes this cost factor very important to the decision maker. However, once again, a very pessimistic 60 percent decrease in the base value for Training Center Operations & Personnel, results in a Pay-back Period which favors Scenario Two (4.93 years) over Scenario One (5.31 years).

The impact Training Center Operations & Personnel has on Pay-back Period and Total Savings, in relation to the impact of all other cost factors considered in the cost comparison analysis, and the sensitivity analysis, makes inclusion of this cost factor in any cost analysis a very important goal of an investment decision maker. Inclusion of this single cost factor provides many benefits, including a margin-for-error as the result of the substantial increase in Total Savings, and reduced risk as Pay-back Period is substantially decreased.

The values used in the Cost Model run for the ILRES Training Center Operations & Personnel cost factor were based on data received from USCG Headquarters (G-WTT) and TRACEN Petaluma, and a personnel costing model (SPC Model) provided by USCG Headquarters (G-CFS). G-WTT provided the FY97 Personnel Allowance List for TRACEN Petaluma. TRACEN Petaluma provided the FY97 budget data for operation of the training center. A detailed description as to how this data was combined to generate the value used in the cost comparison analysis is provided in section 3.5.1.2.2 of this report.

4.3.2.1.2 CBT Design & Development

The sensitivity analysis shows that Pay-back Period has a high sensitivity rating to changes in the CBT Design & Development cost factor, while Total Savings shows a relatively lower sensitivity rate to identical changes in the cost factor's base value. The high sensitivity of Pay-back Period is attributable to Investment Costs being a major part of the formula for calculating Pay-back

Period (Investment Costs divided by NRCBT Annual Savings). CBT Design And Development accounts for 84 percent of the total NRCBT investment cost. However, a pessimistic 40 percent increase in the cost-per-hour of CBT instruction, to design and develop CBT courseware, results in a six month increase in time. The six month increase, which equates to a Pay-back Period of two years and five months, is significantly lower than the Pay-back Period for Scenario One (5 years and 4 months), and 10 months shorter than the Pay-back Period calculated for a similar pessimistic base value change (40 percent) in the ILRES Training Center Operations & Personnel cost factor.

Relative to Pay-back Period, Total Savings is less sensitive to changes in the cost-per-hour of CBT instruction. A pessimistic 40 percent increase in the cost-per-hour of CBT instruction will result in a sizable Total Savings of $666,347 (Table 4-12), a decrease of only $76K. The lower sensitivity rate for Total Savings, in comparison to Pay-back Period, is attributable to the base value used for the CBT Design & Development cost factor making up a low, 19 percent, of total costs to operate the NRCBT course over the projected Course Life-span.

Table 4-12 Changes in Cost-Per-Hour of CBT Instruction

Cost-per-hour Of CBT Instruction	Percentage Change	Pay-back Period	Total Savings
$ 7,600	- 60%	1.06	$ 856,347
$ 11,400	- 40%	1.32	$ 818,347
$ 15,200	- 20%	1.58	$ 780,347
$ 19,000	0%	1.85	$ 742,347
$ 22,800	+ 20%	2.11	$ 704,347
$ 26,600	+ 40%	2.38	$ 666,347
$ 30,400	+ 60%	2.64	$ 628,347

The impact on both Pay-back Period and Total Savings, is small in comparison to the impact of similar changes to the ILRES Training Center Operations & Personnel cost factor. For a course with a Course Life-span of seven years or more, an increase in Pay-back Period under conditions similar to those of Scenario Two, should have little to no impact on the investment decision. In fact, a significant savings would have been realized in Scenario Two, even if costs relative to the design and development of the NRCBT course were doubled. However, when dealing with courses which have a short Course Life-span, it would be beneficial to lower Pay-back Period. Based on the results of the sensitivity analysis, holding down design and development costs can have a positive impact on Pay-back Period. Whether or not a small drop in Total Savings, such as the drop in Total Savings of $76K when the cost factor's base value was decreased 40 percent, will be important to the investment decision maker, is dependent on the costs associated with implementation of the infrastructure to support nonresident training (e.g., interactive CBT, IVT) at USCG duty stations, and how much of those costs were already reflected in the infrastructure related cost factors considered in this cost comparison analysis (i.e., Equipment for Course Distribution).

The base value used in the Cost Model runs for the CBT Design & Development cost factor was based on the cost incurred by R&DC in having an R&DC contractor, Analysis & Technology, Inc., design and develop the CBT version of the AN/WSC-3(v)7 UHF Transceiver Maintenance Course. The CBT version of the AN/WSC-3 course was produced for use in the R&DC pilot study.

4.3.2.1.3 Student Support

Based on the criteria used for determining which of the three sensitivity categories a cost factor comes under, the sensitivity of Total Savings, to a 40 percent change in the NRCBT Student Support cost factor was deemed high. The high sensitivity rating for Total Savings is attributable to the large percentage (68 percent) of the NRCBT's O&M Costs which are made up by the base value used for the Student Support cost factor. And, in turn, the influence on Total Annual Costs to operate the NRCBT version of the course each year. Alone, the Student Support cost factor accounts for 48 percent of the Total Annual Cost to operate the NRCBT version of the course under Scenario Two (Figure 4.8). A pessimistic 40 percent increase in the Student Support cost factor results in a decrease to Total Savings of $142K. However, the decrease of $142K in Total Savings is relatively small, when compared with the $421K drop associated with a similar pessimistic 40 percent change in the ILRES Training Center Operations & Personnel cost factor.

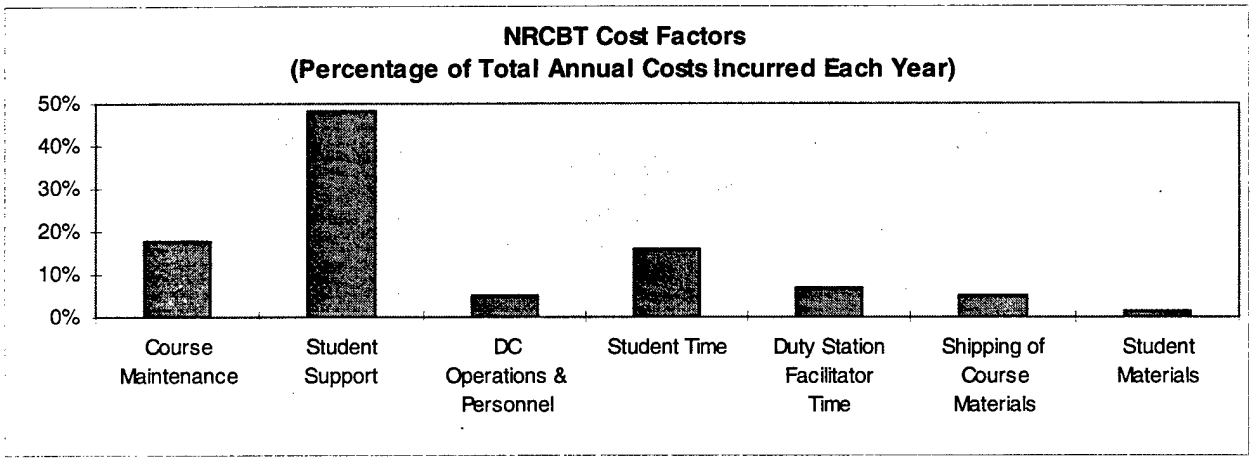

Figure 4-8 Percentage of Total Annual Costs Made Up by each NRCBT Cost Factor

Pay-back Period demonstrated a moderate sensitivity to a 40 percent change in the base value for Student Support. As a result of a pessimistic 40 percent increase in costs to support students taking the NRCBT course, Pay-back Period increases from 1.85 to 2.15 years (2 years and 2 months), an increase of four months. As with Total Savings, when compared to a Pay-back Period of 3.17 years, which results from a similar pessimistic 40 percent change in the ILRES Training Center Operations & Personnel cost factor, a four month increase in Pay-back Period could be considered relatively small. The increase in risk would also be considered small as a 50 percent decrease in the projected Course Life-span, would still result in a Course Life-span greater than the Pay-back Period calculated for Student Support (2.15 years). And, most

important, with a Course Life-span of 3.5 years, Total Savings to the USCG would be $238K. Table 4-13 presents a list of cost values for Student Support, based on percentage changes to the base value listed in Table 4-7(a). Table 4-13 also presents the relative Pay-back Period and Total Savings for each cost level listed.

Table 4-13 Changes in Value used for NRCBT Student Support Cost Factor

Annual Student Support Costs	Percentage Change	Pay-back Period	Total Savings
$ 20,390	- 60%	1.52	$ 956,446
$ 30,585	- 40%	1.62	$ 885,080
$ 40,780	- 20%	1.73	$ 813,713
$ 50,976	0%	1.85	$ 742,347
$ 61,171	+ 20%	1.99	$ 670,980
$ 71,366	+ 40%	2.15	$ 599,614
$ 81,561	+ 60%	2.35	$ 528,248

Although the NRCBT Student Support cost factor does not have the impact of the ILRES Training Center Operations & Personnel cost factor, it is an important factor to the USCG investment decision-maker. Student Support addresses a part of the infrastructure which will need to be set up by the USCG to support the successful implementation of nonresident training (e.g., interactive CBT, IVT) at the duty station. The Student Support cost factor (e.g., Help Desk) addresses costs related to the provision of subject technical support to students taking the nonresident courses at their duty stations. Part, if not all, student support costs associated with each course converted, are accounted for in this cost comparison as the result of considering the Student Support cost factor. Recall that a conservative estimate was made regarding the time of a USCG member to operate a Help Desk, a full man-year (i.e., 2,080 hours). It is more likely the member will have other duties as well, including performing this same task in support of other nonresident courses. Therefore, it is possible that all costs associated with this support requirement may be covered as a result of the conservative estimate (over-estimation). Costs, in addition to the person manning the Help Desk, would include the cost of office space, the cost of communication materials (e.g., telephone, computer), and costs related to supervision.

The base value used in the Cost Model runs was an estimate made by the R&DC analysts. This estimate was made based on discussions with various sources, both inside and outside the USCG.

4.3.2.2 Moderate Sensitivity

Three cost factors are deemed to have moderate sensitivity ratings; Student Transportation (ILRES cost factor), Courseware Maintenance (NRCBT cost factor), and Student Time (NRCBT cost factor).

4.3.2.2.1 Student Transportation

Based on the results of the sensitivity analysis, Total Savings is moderately sensitive to changes in the ILRES Student Transportation cost factor. The moderate sensitivity rating is attributable to this cost factor making up 36 percent of ILRES Per Student Costs (Figure 4-9). As a result, avoiding the expense of transporting the student to-and-from a resident training center ("travel-free" training), by operating the NRCBT version of the course, would have a positive impact on savings. The degree of that impact increases as the Annual Student Throughput Rate considered increases.

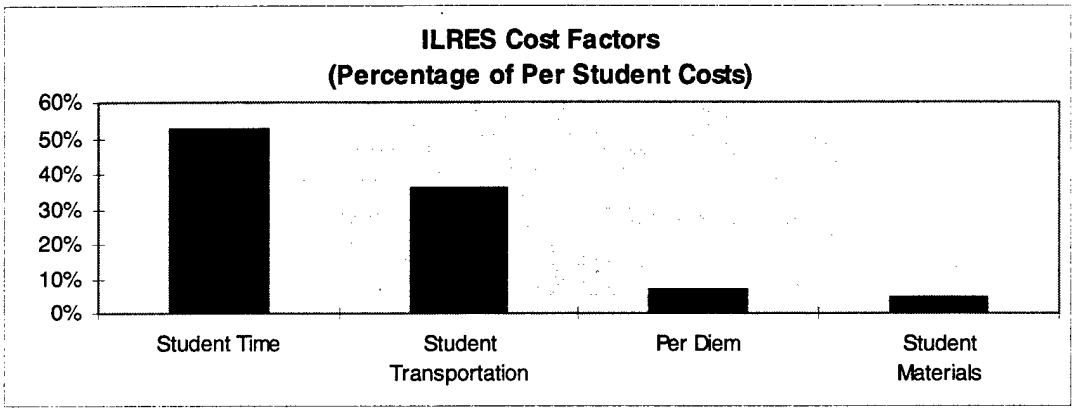

Figure 4-9 Percentage of Per Student Costs Made Up by each ILRES Cost Factor

Based on the Annual Student Throughput Rate considered in Scenario Two (72 students), a decrease in the base value for the Student Transportation cost factor would result in a Total Savings of $641K, a drop in Total Savings of $101K. Although a drop in Total Savings of $101K can be considered a significant decrease, when viewed from a different perspective, comparing the result of Total Savings with that of Scenario One ($85K), a Total Savings of $641 is impressive.

The sensitivity level of Pay-back Period, to a 40 percent decrease in the base value used for the Student Transportation cost factor can be considered low. For example, a 40 percent decrease in the base value used for this cost factor results in a Pay-back Period of 2.05 years (2 years and 1 month). A Pay-back Period of 2.05 years is well below the projected Course Life-span of seven years. Even with a combination of a very pessimistic 60 percent decrease in the Student Transportation cost factor's base value, and a 50 percent decrease in Course Life-span (to 3.5 years), the result is a Pay-back Period (2.17 years) which is less than the value calculated for Course Life-span.

Because of the impact Training Center Operations & Personnel has on the results of Scenario Two, even setting the cost value for Student Transportation to $0 (zero dollars), results in a Total Savings of $490K and a Pay-back Period of 2.46 years. This result highlights once again, the importance of the inclusion of costs related to the operation and staffing of a training center in a

cost comparison analysis. The example of setting the cost value for the Student Transportation cost factor to zero also serves to demonstrate why the FBI's National Security Division was able to achieve substantial savings as the result of partially converting an instructor-led, resident course, held at the FBI Academy in Quantico, Virginia. Partial conversion of an ILRES course (one part nonresident, the other part resident) implies that the need to transport students to-and-from a training center is not eliminated. Partial conversion of the FBI course is discussed in more detail in section 5.1.5 of this report (Partial Conversion Of An Existing ILRES Course).

Table 4-14 presents a list of cost values for the Student Transportation cost factor based on percentage changes to the base value listed in Table 4-7(b). Table 4-14 also provides the relative Pay-back Period and Total Savings for each cost level listed.

Table 4-14 Sensitivity Relative to Value Changes for Student Transportation

Per Student Transportation Cost	Percentage Change	Pay-back Period	Total Savings
$ 200	- 60%	2.17	$ 591,147
$ 300	- 40%	2.05	$ 641,547
$ 400	- 20%	1.94	$ 691,947
$ 500	0%	1.85	$ 742,347
$ 600	+ 20%	1.76	$ 792,747
$ 700	+ 40%	1.68	$ 843,147
$ 800	+ 60%	1.61	$ 893,547

The base value used in the Cost Model runs for the Student Transportation cost factor was received from USCG Headquarters (G-WTT). The dollar value provided by G-WTT is used in the USCG budget build process.

4.3.2.2.2 Courseware Maintenance

The annual cost of CBT courseware maintenance is calculated as a percentage of the cost to design and develop it. In performing the sensitivity analysis for the NRCBT Courseware Maintenance cost factor, the base value used for the CBT Design & Development cost factor was held constant, while percentage changes were made to the base value used in calculating the Courseware Maintenance cost factor.

Based on the threshold criteria for determining moderate levels of sensitivity, Total Savings has a moderate sensitivity to changes in the base value used for the Courseware Maintenance cost factor, and Pay-back Period has a low sensitivity to identical changes in the cost factor's base value. As can be seen in Table 4-15, a pessimistic 40 percent increase in the base value used for the Courseware Maintenance cost factor results in a Total Savings of $689K. A drop in Total Savings of $53K from that calculated for Scenario Two. A similar, pessimistic change in the base value for the ILRES Student Transportation cost factor results in a Total Savings decrease of $101K. In comparison to the result for the Student Transportation cost factor, the drop in

Total Savings due to a 40 percent increase in the base value of the Courseware Maintenance cost factor could be considered relatively small ($101K versus $53K).

The sensitivity of Pay-back Period, to changes in the NRCBT Courseware Maintenance cost factor, can be considered small. For example, a very pessimistic 60 percent increase in this cost factor's base value results in a Pay-back Period of two years and one month (2.01 years), which is less than a 50 percent decrease in Course Life-span (3.5 years).

Table 4-15 presents a list of values used in generating the cost of CBT courseware maintenance for the Courseware Maintenance cost factor. Table 4-15 also provides the relative Pay-back Period and Total Savings for each cost factor value listed.

Table 4-15 Sensitivity Relative to Value Changes for Courseware Maintenance

Percentage of CBT Design & Development Cost	Annual Courseware Maintenance Cost	Percentage Change	Pay-back Period	Total Savings
4 %	$ 7,600	- 60%	1.71	$ 822,147
6 %	$ 11,400	- 40%	1.76	$ 795,547
8 %	$ 15,200	- 20%	1.80	$ 768,947
10 %	$ 19,000	0%	1.85	$ 742,347
12 %	$ 22,800	+ 20%	1.90	$ 715,747
14 %	$ 26,600	+ 40%	1.95	$ 689,147
16 %	$ 30,400	+ 60%	2.01	$ 662,547

The base value used to generate this cost factor was provided by NAWC. The value was based on a generally accepted "rule-of-thumb", which is applied by many cost analysts and economists in the training community.

4.3.2.2.3 Student Time (NRCBT)

In performing the sensitivity analysis for the NRCBT Student Time cost factor, the cost of student time was held constant (i.e., $18.25 per hour), while percentage changes were made to the student completion time for the NRCBT course.

Total Savings was deemed to be moderately sensitive to changes in the NRCBT Student Time cost factor. Pay-back Period was deemed to have a low sensitivity to an identical change in the cost factor's base value. As with the NRCBT Courseware Maintenance cost factor, the affect on Total Savings as a result of a very pessimistic 60 percent increase in the time it takes a student to complete the NRCBT course, has to be considered small, when compared to an identical pessimistic change in the ILRES Student Transportation cost factor. Most important, a 60 percent increase in time for the student to complete the NRCBT course (i.e., 20.8 hours) results in a significant Total Savings over the projected Course Life-span of $670K.

Table 4-16 presents Total Savings and Pay-back Period results, based on percentage changes to the arithmetic mean Student Time.

Table 4-16 Sensitivity Relative to Value Changes in Student Time

Time To Complete Course	Percentage Change	Pay-back Period	Total Savings
5.2	- 60%	1.73	$ 814,091
7.8	- 40%	1.76	$ 790,176
10.4	- 20%	1.80	$ 766,262
13.0	0%	1.85	$ 742,347
15.6	+ 20%	1.89	$ 718,432
18.2	+ 40%	1.94	$ 694,517
20.8	+ 60%	1.99	$ 670,602

In an effort to quantify Student Time reduction resulting from CBT implementation, the R&DC analysts conferred with experts in and out of the USCG. Their experience has shown a 40 to 60 percent net reduction in Student Time following CBT implementation versus traditional resident based training. The reduction in Student Time measured by the pilot study was 64 percent.

Contacts at the NAWC suggested the review of a paper published by J. D. Fletcher in a conference proceeding of the Society for Applied Learning Technology (1996). In that paper, J. D. Fletcher states that "reductions of about 30 percent in the time it takes students to reach a variety of instructional objectives seems to be a good bet". (The paper published by J. D. Fletcher, and other valuable information related to training technologies, can be accessed at the web site **www.ott.navy.mil**.)

Applying J. D. Fletcher's 30 percent student time reduction to the value used for Scenario Two yields a 25.5 hour NRCBT student completion time. At 25.5 hours, a Total Savings of $627K, and a Pay-back Period of 2.09 years (2 years and 2 months), are calculated. The calculated Pay-back Period increased by only 3 months in comparison to the Pay-back Period calculated for Scenario Two, therefore, even a 30 percent reduction in student time favors investment in the NRCBT version of the course.

Certification of course completion for an NRCBT course is an important Student Time sub-factor that remains unresolved. If testing is performed, via computer-based training or some other method, as a requisite for certification, overall Student Time will increase. Based on the findings of this sensitivity analysis, the increased time related to testing and certification of students should not affect the favorable results of the Scenario Two for the NRCBT investment.

4.3.2.3 Low Sensitivity

Table 4-17 lists the cost factors which show little, to no impact, on both Pay-back Period and Total Savings. Changes of 60 percent to the base value of these cost factors results in less than a five (5) percent impact on either Pay-back Period or Total Savings. To get a feel as to how

insignificant these changes were in comparison to all the cost factors considered in the sensitivity analysis, one only has to review the tornado diagrams presented in Figures 4-6(a) and 4-6(b).

Table 4-17 Cost Factors with a Low Sensitivity Rating

Cost Factor	Group
Duty Station Facilitator Time	NRCBT
Shipping of Course Materials	NRCBT
Student Materials	NRCBT
DC Operations & Personnel	NRCBT
CBT SME Support	NRCBT
Equipment for Course Distribution	NRCBT
Student Materials	ILRES

Those cost factors that are related to Per Student Costs would increase in significance, if the Annual Student Throughput Rate were to increase above 72 students. However, as long as savings from the difference in Annual Student Costs (NRCBT versus ILRES) favors NRCBT course, the rise in student throughput would only serve to increase Total Savings as the result of operating the NRCBT course. A similar effect would occur with cost factors relative to O&M Costs, if the Course Life-span were to increase, and cost factors relative to Investment Costs would increase in significance as Course Life-span decreases, or costs to develop a course increase.

4.3.3 COMPARING TREATMENTS OF THE TRAINING CENTER OPERATIONS & PERSONNEL COST FACTOR

In performing this sensitivity analysis, two separate Cost Model runs were made. The first run treated the ILRES Training Center Operations & Personnel cost factor as an O&M Cost. The cost value used for Training Center Operations & Personnel of $150,206 was held constant across all levels of annual student throughput considered. The second run treated the Training Center Operations & Personnel cost factor as a Per Student Cost. The per student cost used in that Cost Model run was $2,151 for Training Center Operations & Personnel.

A comparison of Pay-back Periods, between consideration of the Training Center Operations & Personnel cost factor as an O&M Cost, and as a Per Student Cost, is presented in Table 4-18(a). There is a significant difference between Pay-back Periods below an Annual Student Throughput Rate of 60 students. At 36 students per year, the Pay-back Period for Per Student Cost would be greater than the Course Life-span, resulting in a loss of training dollars, rather than a savings. Above an Annual Student Throughput Rate of 72, Pay-back Period results favor Per Student Cost, but there is no significant difference.

Table 4-18(a) Comparison of Pay-back Periods (In Years)

Annual Student Throughput Rate	Consider as Annual Cost	Consider as Per Student Cost
36	2.28	7.25
48	2.10	3.58
60	1.95	2.40
72	1.85	1.85
84	1.74	1.50
96	1.64	1.26
108	1.56	1.10

When comparing the difference in Total Savings (Table 4-18(b)), treatment as an O&M Cost is favored in the low ranges of Annual Student Throughput Rate, while treatment as a Per Student Cost is favored in the high ranges of Annual Student Throughput Rate. At an Annual Student Throughput Rate of 36 students, which results in a loss, rather than a savings when treated as a Per Student Cost, the difference in Total Savings favors O&M Cost by a little more than $500K. At an Annual Student Throughput Rate of 108 students, the difference in Total Savings favors Per Student Cost by a little more than $500K. The gap continuously grows in favor of Per Student Cost as the Annual Student Throughput Rate increases above 72.

Table 4-18(b) Comparison of Differences in Total Savings

Annual Student Throughput Rate	Annual Cost	Per Student Cost
36	$ 516,982	$ (8,741)
48	$ 593,487	$ 243,006
60	$ 669,993	$ 494,752
72	$ 742,347	$ 742,347
84	$ 818,852	$ 994,093
96	$ 895,358	$ 1,245,840
108	$ 971,864	$ 1,497,586

The difference in Pay-back Period and Total Savings illustrates why there was concern expressed during development of the Cost Model as to how costs related to training center operations and personnel should be handled. This concern is magnified when an analyst considers the high sensitivity of Pay-back Period and Total Savings to percentage changes in the cost of operating and staffing a resident training center. These concerns factored into the R&DC analyst's decision to treat this cost factor as an O&M Cost for purposes of this cost comparison effort. Interestingly enough, treatment of this cost factor as an O&M Cost resulted in a savings, despite a pessimistic 60 percent decrease in its cost value.

4.4 "WHAT-IF" SCENARIO MODEL RUNS

This subsection explores the affect on savings if the USCG were able to recoup, or avoid costs related to equipment requirements for the ILRES classroom and lab, and costs related to space requirements where the ILRES course resides. Scenario Two is used as the basis for this set of Cost Model runs. The only data input changes are to the ILRES cost factors Classroom & Lab Equipment, and Classroom & Lab Space.

4.4.1 CLASSROOM & LAB EQUIPMENT

At a cost of $502K, the consideration of the ILRES Classroom & Lab Equipment cost factor will more than offset the investment cost of $266K in the NRCBT version of the course. As a result, the Pay-back Period would be zero. All savings which result from cost differences for both O&M Costs and Per Student Costs would go toward Total Savings. A savings rate of $144,082 for each year of operation of the NRCBT course would be realized.

To achieve this cost advantage, a scenario involving the replacement of an existing ILRES course would require the sale of existing equipment to another organization, or the equipment has value to another part of the organization and is used as a cost avoidance. If there were a scenario in which a new training requirement resulted in the need to purchase equipment that was not in the USCG inventory, and the development and operation of a NRCBT version of that course would result in elimination of the need to purchase that equipment (cost avoidance), the cost to purchase the equipment could then be considered in the cost comparison analysis as a savings. It is important to note that not all ILRES courses in the USCG have equipment inventory costs of this level.

A sensitivity analysis was performed to determine the sensitivity of Pay-back Period and Total Savings to changes in costs for classroom and lab equipment. A 60 percent decrease in the cost value for classroom and lab equipment had no affect on Pay-back Period. Pay-back Period remained at zero, as the combination of savings from classroom and lab equipment, along with the O&M Cost savings (ILRES O&M Costs - NRCBT O&M Costs), offset the investment cost for the NRCBT version of the course. With a 60 percent decrease in value, Total Savings was $943,147, or a decrease in Total Savings of 24 percent.

The lack of sensitivity for Pay-back Period to changes in the cost value for Classroom & Lab Equipment is attributable to its offsetting the investment cost of the NRCBT course. Figure 4-10 shows NRCBT Investment Costs ($266K) in relation to changes in the cost value used for Classroom & Lab Equipment, and in relation to a combination of O&M Cost Savings (ILRES O&M Cost - NRCBT O&M Cost) and percentage changes in the cost value for Classroom & Lab Equipment. As demonstrated in Figure 4-10, above 53 percent, the cost value for Classroom & Lab Equipment is greater than the investment cost in the NRCBT course. Pay-back Period will be zero and NRCBT Annual Savings for each year of operation for the NRCBT course will be $144K. Between 39 and 53 percent, the combination of savings from avoiding or recovering ILRES equipment costs, and the first year of NRCBT Annual Savings, will cover the cost of

investing in the NRCBT version of the course. Pay-back Period will remain at zero, although savings in the first year of operation will be some fraction of $144K. Below 39 percent, Pay-back Period rises above zero years.

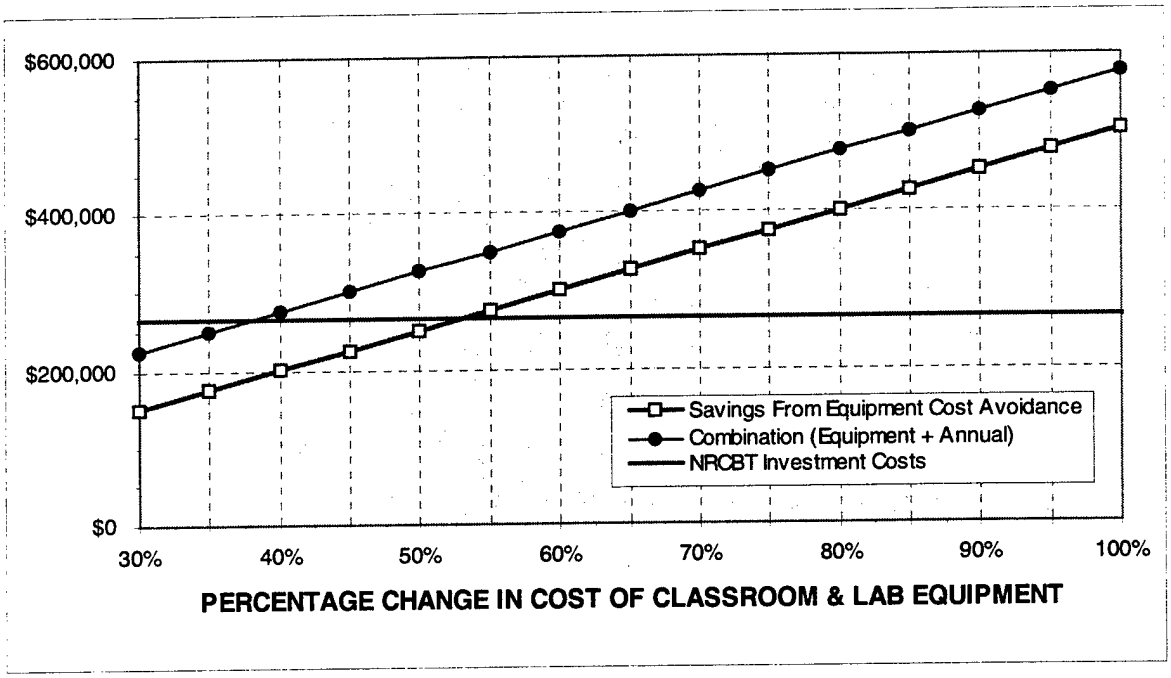

Figure 4-10 Classroom & Lab Equipment Costs, Based on Percentage Changes in Value

4.4.2 CLASSROOM & LAB SPACE

The consideration of the Classroom & Lab Space cost factor, which was treated as an ILRES Investment Cost, resulted in a Pay-back Period of 0.22 years (approximately 3 months). In comparison to the Pay-back Period calculated for Scenario Two, consideration of this ILRES cost factor resulted in an 88 percent reduction in the Pay-back Period.

To achieve this cost advantage, a scenario would have to exist in which the cost of the space where the ILRES course resides, can be recovered through sale or other means, or the space can be used by another part of the organization and result in a cost avoidance. As with the Classroom & Lab Equipment cost factor, if a new training requirement were to occur which required the purchase of space and development and deployment of a nonresident (e.g., interactive CBT, embedded training, correspondence) version of the course would eliminate the need for that space purchase, then the cost of that space can be considered in the cost comparison analysis.

A sensitivity analysis was performed to determine the sensitivity of Pay-back Period and Total Savings to changes in costs for the ILRES classroom and lab space. Pay-back Period was extremely sensitive to decreases in the value considered. There was a about 100 percent increase in Pay-back Period for every 10 percent decrease in the cost value. However, a pessimistic

decrease of 60 percent for the Classroom & Lab Space cost factor, the Pay-back Period was 1.36 years. A Pay-back Period which is less than that of Scenario Two (1.85 years). The sensitivity of Total Savings, to the percentage changes in the Classroom & Lab Space cost factor was low. A 60 percent decrease in the cost factor value resulted in an 11 percent decrease in Total Savings.

5 DISCUSSION

Based on the analysis of results from the cost comparison model runs, replacement, where appropriate, of existing ILRES courses with an equivalent NRCBT version, has the potential to save training dollars. However, the extent to which this potential is realized in actual dollars saved, is dependent on the decisions management makes concerning implementation of NRCBT. Five scenarios, where implementation of NRCBT may be beneficial to the USCG, are discussed. Also discussed are issues, which will affect savings from NRCBT, the application of Net Present Value to delineate between training investment options, and how the results of the cost comparison analysis might be extrapolated to make a first-cut estimate on a large scale conversion of ILRES courses in the USCG.

5.1 SCENARIOS

Which cost factors can be considered in a cost comparison is dependent on the scenario faced by management. It should be noted, for each course considered as a potential candidate for a nonresident variant (e.g., interactive CBT, embedded training, correspondence), an analysis must be performed to ensure that the variant would be appropriate, and that the proper media mix (e.g., interactive CBT, embedded training, IVT, correspondence) is considered. Applying the proper media mix will ensure a cost-effective solution.

5.1.1 REPLACEMENT OF SINGLE EXISTING ILRES COURSE

The replacement of a single, existing ILRES course, with an equivalent NRCBT version of the same course, will not affect the costs associated with the operation and staffing of a training center. As the results of the Cost Model run for Scenario One indicate, replacement of a single, existing ILRES course could save money. But how much, if any savings will be realized, is highly sensitive to the non-cost factors Annual Student Throughput Rate and the Course Life-span. For example, a drop in Annual Student Throughput Rate below 59 students would result in a loss to the USCG. And with a Pay-back Period of 5.31 years, a 25 percent decrease in Course Life-span would result in a loss to the USCG. This sensitivity to changes in the non-cost factors, Annual Student Throughput Rate and Course Life-span, leaves little room-for-error when making a decision as to whether or not to replace an existing ILRES course, with an equivalent NRCBT version of that course. Therefore, the best candidates under conditions similar to those of Scenario One would be courses with a high Annual Student Throughput Rate, and a short Pay-back Period relative to Course Life-span.

5.1.2 REPLACEMENT OF A "MEANINGFUL" NUMBER OF EXISTING ILRES COURSES

Scenario Two involves the replacement of a "meaningful" number of existing ILRES courses with an equivalent, nonresident variant (e.g., interactive CBT, embedded training, correspondence) of each course. This allows for re-organization of the USCG training structure to save approximately the proportion of training center costs shared by each course conversion. The impact on Pay-back Period and Total Savings, as a result of the ILRES Training Center Operations & Personnel cost factor being considered in Scenario Two, is apparent when comparing the results of the Cost Model runs for Scenarios One and Two, which are presented in Table 5-1. The effect is even more dramatic considering that Total Savings for Scenario Two ($742,347), represents the savings of only one of a multiple number of courses which were replaced with (converted to) a nonresident variant.

Table 5-1 Comparing Results of Scenarios One and Two

	SCENARIO ONE	SCENARIO TWO
Total Savings	$ 84,712	$ 742,347
Pay-back Period	5.31 years	1.85 years

Equally impressive is the insulation effect to changes in various factors which is provided when training center operations and personnel costs are considered. In section 4.3 of this report (Sensitivity Analysis Model Runs), a sensitivity analysis was performed to determine the affect on Scenario Two's Pay-back Period and Total Savings, as the result of changes to various factors considered in the Cost Model. When the consequences of changes in Annual Student Throughput Rates were explored, despite the most pessimistic decrease in Annual Student Throughput Rate (i.e., zero student throughput), an acceptable Pay-back Period and a positive Total Savings resulted for Scenario Two. And most important, with a 60 percent decrease in the ILRES Training Center Operations & Personnel cost factor, the Total Savings of $111,480 was greater than the Total Savings for Scenario One ($84,712). Therefore, Scenario Two would be the preferred situation for management. Scenario Two offers the greatest opportunity for savings, and management is provided a margin-for-error as the final investment decision will be made based on the forecasting of future events and costs.

5.1.3 NEW TRAINING REQUIREMENTS

A new training requirement indicates that either the ILRES version of the course does not exist, or the ILRES course would require modification (upgrade) to meet the new requirements. As a result of the new training requirements, cost factors, such as Classroom & Lab Equipment and Classroom & Lab Space, may become part of the cost consideration. Cost Model runs were performed in section 4.4 of this report ("What-if" Scenario Model Runs) regarding the consideration of those two cost factors. The results of those model runs demonstrates that if the

ILRES version of the course requires a substantial investment in equipment, or space must be acquired through construction, modification, or leasing, the funds saved by choosing the NRCBT variant of the course could offset the NRCBT investment costs. Therefore, any funds saved from the combination of O&M Costs and Per Student Costs would be "pure profit" (using a phrase from the private sector) from day one. The risk for choosing an equivalent NRCBT version over an ILRES version would be zero.

5.1.4 RELOCATION OF ILRES COURSES

Relocation of existing ILRES courses, if space does not exist, may require the acquisition of space through construction, modification, or leasing. Cost avoidance in the acquisition of space, as well as moving or purchasing new classroom and lab equipment, may offset the costs of investing in an equivalent, NRCBT version, of that same course.

5.1.5 PARTIAL CONVERSION OF AN EXISTING ILRES COURSE

Dividing an existing ILRES course into two parts: ILRES and NRCBT. The National Security Division of the Federal Bureau of Investigation (FBI) successfully converted the two-week, 80-hour, residency Basic Counterintelligence In-Service (BCI) course into two parts (Boord, 1997). The first week (40-hours) of the course was converted to an equivalent, NRCBT course, which the students completed in 15 hours. The second week of the course remained as a 40-hour ILRES course. Although travel was not eliminated, dollars were saved as there was a need in the FBI to increase annual student throughput of the course. The limitation for the two-week resident version of the course was scheduling restrictions due to space availability at the FBI Academy, both classroom and boarding. By reducing the ILRES portion of the course to one week, the National Security Division of the FBI has more than doubled student throughput. Dollars saved, which have been estimated in excess of $1.8 million over a three-year period, were not only associated with eliminating the need to expand the facilities, but with the reduction of student time to complete the first part of the course (one-week to 15 hours). Since a FBI Agent works on average, a 50-hour work week, the student (agent) time savings was 35 hours.

The USCG has multiple-week ILRES courses (e.g., A-Schools, SATCOM). Some of these courses may not be appropriate for total conversion to a nonresident delivery method (e.g., interactive CBT, embedded training, correspondence), but it may still be cost effective to convert part of the ILRES course. As with the FBI example, resident courses for which Program Managers would like to increase student throughput, but increases in student throughput are constrained by limitations of the resident training center or logistics, are potential candidates for consideration of partial conversion.

5.2 ISSUES RELEVANT TO NONRESIDENT CBT TRAINING COSTS

What follows is a discussion of some of the issues that are relevant to savings realized, as the result of implementing NRCBT. Some of the issues discussed below involve possible ways to increase savings.

5.2.1 INFRASTRUCTURE

To realize the maximum benefits for both cost and effectiveness of nonresident training (e.g., interactive CBT, embedded training, correspondence), an infrastructure must be in place which will support its successful implementation. As stated by a number of sources (e.g., Department of Energy), the major reason for failure of nonresident training in most organizations is the lack of an adequate infrastructure to support its implementation. The development and deployment of such an infrastructure in the USCG will require some portion of the savings from nonresident training to be reinvested in that infrastructure. But how much the development and deployment of that infrastructure will cost is dependent on what that infrastructure will consist, and how it is deployed.

Infrastructure cost issues, accounted for in the Cost Model, are NRCBT cost factors, Equipment for Course Distribution, Shipping of Course Materials, Courseware Maintenance, Student Support, Distribution Center Operations & Personnel, and Facilitator Time. Delivery of the NRCBT course, which affects the cost factors Equipment for Course Distribution and Shipping of Course Materials, is one area where costs could be decreased on the NRCBT side of the cost comparison.

5.2.1.1 Delivery of a Nonresident CBT Course

During the pilot study, delivery of the NRCBT course was accomplished by shipping a multimedia laptop computer and relative course materials (e.g., set of U.S. Navy technical manuals) between the distribution center and the participating duty station. This could be considered a worst case scenario for the following reasons:

1. Shipping costs for the equipment was $72 (round-trip) per student. Course materials for the NRCBT course had to be shipped Federal Express, as the pilot study required tight controls on the time period in which the training could take place at the duty station. Once the start date for beginning the course was reached, the student had two weeks to complete the course. At the end of that two-week period, whether or not the student completed the course, the student went TAD to TRACEN Petaluma to be evaluated by subject matter experts on the actual AN/WSC-3(v)7 UHF transceiver (using realistic problems in a near-working environment, not unlike the duty station). In addition, because of the nature of scheduling courses like the AN/WSC-3 course, and the difficulty in those class schedules aligning with the operational schedules of the various units where potential students reside, identity of students, even for the resident version of the course under normal conditions, is not known until a week to three weeks before the class is to convene.
2. Each time the equipment was in transit, there was a risk of damage or loss. The purchase cost per laptop computer was $4,000. Loss or damage of it would be an added expense to the operation of the NRCBT course. Loss or damage of equipment would also delay completion of training.
3. Once the equipment arrived at the duty station, one student used the laptop computer for only one specific course. This was an inefficient use of a valuable resource, especially when the strength of CBT courseware is that multiple students can take the course. For the pilot study, this

limitation of one student taking the course was imposed based on experimental control requirements for the pilot study. However, limitation of the laptop computer to one course is a logistics problem that will occur as long as nonresident training is performed using a shared resource, among widely dispersed geographic locations. In the case of the AN/WSC-3 course, the laptop computer with installed CBT courseware must be sent to a student, and upon completion of the course, it must be returned to a distribution center, that will in turn, send it to a student at the next location.

4. Turnaround time for the equipment was another factor contributing to the inefficient use of a valuable resource. In the pilot study, turnaround time was four weeks. This time includes: a week in transit to the duty station, two weeks for a single student to complete the course at that duty station, and then a week to return the computer (note: in the cost comparison, turnaround time was set at five weeks to account for delays which may occur in moving the laptop computer between duty stations). During the weeks in transit, the laptop computer, a $4K piece of equipment, was not being utilized for training or other USCG activities that require a computer (e.g., administration).

Alternative methods exist for delivering NRCBT courses to students at the duty station. These alternative methods have the potential of lowering delivery costs for the NRCBT course (increased savings) and simplifying the distribution process (e.g., configuration management). Two alternatives are discussed, but should not be limited to just these options in considering more ideal ways to deliver the NRCBT courses.

5.2.1.1.1 Each Duty Station Has A Computer(s) for Training

Each duty station should have one or more computers that are available for, and can support, training of personnel at their duty stations. In such a situation, the CBT course (CD-ROM only, no laptop computer) can either be shipped to a duty station as required, or copies of the various CBT courses available could become part of the duty station library.

According to the R&DC Information Resource Management (IRM) Officer, the latest USCG Standard Workstation III's (CGSWIII) are being delivered to USCG units with multimedia capability built in. This capability includes a sound card and a CD-ROM. For training purposes, a unit may wish to add a set of headphones or speakers. For older versions of the CGSWIII delivered to USCG units without multimedia capability, the computer can be upgraded for about $200 per computer (i.e., sound card, CD-ROM, headphones).

Advantages of having computers that can be used for training personnel at their duty stations are:

1. Decreases shipping costs dramatically, and the risk of damage or loss to the laptop computer would be eliminated. With the elimination of shipping laptop computers each time a student requires training, shipment of materials would be limited to the CD-ROM disk, student guide, and technical manuals. Shipping cost would be further reduced if the student guide and technical manuals were put on CD-ROM as well. The student guide could be printed out for the student at the duty station. Putting technical manuals on CD-ROM would not only lessen the shipping

costs for a training course, but save valuable space at duty stations (especially vessels) as a CD-ROM could replace the bulky paper-based technical manual.
2. If the course is part of the duty station library, the course can be taken on-demand. This could be defined as a form of Just-In-Time Training as the course could be accessed and reviewed when the need arises. An additional benefit will be refresher training as personnel can review materials whenever, and as often, as they wish. The drawback to having copies of the course at each duty station library will be configuration management. It is possible that the duty station library does not have the most up-to-date version of the course.
3. Computers, which are an expensive resource, can be used for many courses, and by many students. Instead of the cost of a $4,000 computer being accessed to the total cost of one course, the cost of the computer would be dispersed over many courses. The computer would also be available at the duty station for other needs.

5.2.1.1.2 Access Course Over The Web

A student accesses the NRCBT version of the course at a Web Site. This would still require access to a computer, with the additional requirement of a communication line. However, this is considered the optimal of the two alternatives for the following reasons:

1. Eliminates shipping costs and other shipping concerns (e.g., breakage of equipment, loss of materials in transit). Loss or breakage of equipment results in delays for a student to complete the course, as well as, creates additional costs for operation of the NRCBT course.
2. The course can be accessed on demand. Processing time, relative to shipping of any course materials, is eliminated. In addition, administrative (overhead) concerns diminish, including those of the duty station facilitator.
3. Configuration management is optimized. Everyone is accessing the latest version of the course posted, which in turn increases the standardization of the NRCBT course.
4. Administration of tests and other relative duties could be performed using the Web.

5.2.1.2 Cost of Multimedia Computer Systems Continues to Decrease

Since the procurement of the multimedia laptop computers for the pilot study was completed in FY96, the cost of equivalent multimedia computer systems has decreased by nearly 50 percent. This decrease in cost is expected to continue over the foreseeable future. From a cost comparison perspective, this decrease in cost will increase the appeal of the nonresident CBT investment. For example, a 50 percent drop in the cost of the computers required to support an Annual Student Throughput Rate of 72 students results in a $17K decrease in NRCBT Investment Costs.

5.2.2 CBT COURSEWARE DEVELOPMENT COSTS

The NRCBT CBT Design & Development cost factor accounts for 71 percent of the NRCBT investment costs in both Scenarios One and Two. If the CBT design and development costs for the NRCBT course could be decreased, the Pay-back Period would be shortened, and Total

Savings would increase. Table 5-2 shows, for both Scenarios One and Two, the affect on Pay-back Period and Total Savings from decreases in cost for CBT design and development. The improvement in Total Savings for Scenario One, with a 60 percent decrease in CBT design and development costs, makes a management decision to invest in the NRCBT version of the course less riskier (margin-for-error has more than doubled).

Table 5-2 Effect of Changes to Cost-Per-Hour of CBT Instruction

		SCENARIO ONE		SCENARIO TWO	
Cost Per CBT Instructional Hour	**Percentage Decrease in Cost**	**Pay-back Period**	**Total Savings**	**Pay-back Period**	**Total Savings**
$ 19,000	0%	5.31	$ 84,712	1.85	$ 742,347
$ 15,200	-20%	4.55	$ 122,712	1.58	$ 780,347
$ 11,400	-40%	3.79	$ 160,712	1.32	$ 818,347
$ 7,600	-60%	3.04	$ 198,712	1.06	$ 865,347

RTC Yorktown, a USCG training center located in Yorktown, Virginia, has personnel exploring various software packages and approaches which would decrease time and costs associated with the CBT design and development process. In addition, CBT is one of a number of media alternatives which could be employed for nonresident training, delivered to students at their duty station. Many of these media are a less expensive alternative to CBT. What is important, as each media has various strengths and weaknesses, is to perform an analysis for each course considered, to determine whether it is appropriate for conversion to an equivalent nonresident version, and what the media mix should be. This would ensure application of the most cost effective media solution.

5.2.3 EFFECTIVENESS OF TRAINING

Effectiveness of training is critical to actual savings, or losses, which will be realized by the USCG. Whether the training delivery method is ILRES or nonresident (e.g., interactive CBT, embedded training, IVT, correspondence), if the training does not achieve the objective, there could be additional costs (both time and dollars) incurred by the USCG. These additional costs due to ineffective training are not always apparent (e.g., USCG military people technically do not receive overtime pay for additional hours spent in resolving a problem, so additional time requirements, as the result of ineffective training, will not be accounted for in personnel costs). If an individual assigned to perform a task has not been adequately trained, the individual or supervisors may fill the gap through On-The-Job Training (OJT), trial-and-error, or some other method. It is also possible that additional personnel will be required to assist on a task that should have required only one person. And the worst case scenario, inadequate training could lead to a loss of life or major damage to a mission-critical system.

5.3 USING NET PRESENT VALUE TO COMPARE TRAINING INVESTMENT OPTIONS

5.3.1 DEFINITION BY EXAMPLE

Net Present Value (NPV) is based on the concept that a dollar in one's hand today, is worth more than the same dollar a year from now. When deciding between two investment opportunities, putting a dollar in the bank or investing that dollar in Project A, the possessor of the dollar will want to know what the possessor will get in return for investing that dollar (Rate-of-Return) in Project A. If investment of that dollar in Project A will result in a Rate-of-Return less than that paid by a bank (e.g., 3 percent), the possessor will put the dollar in the bank.

In making the investment decision, between Project A and the bank account, the possessor could apply NPV. NPV is the present value of future cash flows, minus the cost of the initial investment (Ross S., Westerfield R., and Jaffe J.). Present value is a stream of cash flows, which are spread out over a period of several years, reduced (discounted) to a current dollar value based on a desired Rate-of-Return. In the NPV formula, desired Rate-of-Return is designated as Discount Rate.

NPV = PV(Discount Rate, Cash Flow) - Investment Cost

For the possessor of the dollar, the desired Rate-of-Return will be at least 3 percent, since the possessor is assured of getting three (3) percent from the bank. Using the NPV formula, the possessor would enter the value three (3) for Discount Rate. The user would enter $1 for Investment Cost. Table 5-3 presents NPV of Cash Flow, based on three different cash flows entered by the possessor. If the NPV of Cash Flow is $0, then the result of NPV of Cash Flow will support investment of the dollar in Project A, as the possessor will recover the cost of the investment ($1), plus achieve the desired Rate-of-Return. If NPV of Cash Flow is greater than $0, the possessor will receive a greater Rate-of-Return than desired. If NPV of Cash Flow is less than $0, then NPV of Cash Flow indicates that the investment of the dollar in Project A should not be made. The possessor will not receive the desired Rate-of-Return from investment in Project A when NPV is negative.

Table 5-3 Example of Applying Net Present Value

CASH FLOW	NPV OF CASH FLOW
$ 1.02	($ 0.01)
$ 1.03	$ 0.00
$ 1.04	$ 0.01

5.3.2 APPLICATION OF NET PRESENT VALUE

5.3.2.1 Use Of NPV In Private And Public Organizations

NPV is used in the public sector to determine when to accept or reject an investment opportunity (Capital Expenditure Analysis). Based on a survey by Blume, Friend, and Westerfield, discounted cash flow methods, which NPV is a part of, are the most frequently used in performing a Capital Expenditure Analysis (Ross S., Westerfield R., and Jaffe J.). Discounted cash flow methods are favored over all other Capital Expenditure Analysis methods. The strength of NPV is that NPV accounts for the Rate-of-Return desired by the decision-maker, as well as, the cost of the initial investment. The Rate-of-Return can be a value which represents a desired profit from an investment, the cost of borrowing money to finance startup costs for a project, inflation considerations, or a combination of considerations.

5.3.2.2 Use Of NPV In USCG Training Community

For the USCG training community, investment in nonresident alternatives of delivering training (e.g., computer-based training, embedded training, IVT) may require a large, up-front expenditure. The large expenditure will be for both setting up an infrastructure to support the successful implementation of nonresident training delivered at the duty station, and for conversion of a large number of existing ILRES courses, in a relatively short time frame. The NPV can be applied to anticipated future savings, which would result from investment in nonresident training at the duty station, to demonstrate that the USCG will realize a desired Rate-of-Return on the up-front investment. The Discount Rate used in calculating the NPV of Total Savings could be the cost of borrowing money for the U.S. Government (e.g., U.S. Savings Bonds), or tied to the anticipated percentage decrease in the USCG budget. If the NPV of Total Savings is positive, the NPV of Total Savings could be used to justify a realignment of funds, or some other financing alternative, to support the USCG training community's move from ILRES, where appropriate, to nonresident training provided at the student's duty station.

5.5.2.3 Application In Cost Comparison Effort

Comparison Of Scenarios One And Two

In generating NPV of Total Savings for this cost comparison effort, G-CFS recommended using rates published in the Office of Management and Budget's (OMB) Circular Number A-94. G-CFS based that recommendation on a directive presented in a manual entitled "Information Technology Benefit-Cost Analysis (BCA) Manual", which was published by the USCG Headquarters Office of Architecture and Planning (G-SIA). The directive states that "ALDIST 061/93 0120021Z mar93 require that the use of any other rate must be pre-approved by COMDT (G-CPP)". Table 5-4 presents the discount rates published in Appendix C (January 1998

Revision) of the OMB Circular No. A-94. (OMB Circular No. A-94 can be accessed at web site **www.whitehouse.gov/WH/EOP/OMB/html/circulars/a094/a094.html.)**

Table 5-4 OMB Published Discount Rates for January 1998

TIME	3-Year	5-Year	7-Year	10-Year	30-Year
RATE	5.6	5.7	5.8	5.9	6.1

Figure 5-1 shows the NPV of Total Savings over a range of Annual Student Throughput Rates, for both Scenarios One and Two. The space between the two lines on the graph is the difference between consideration of the ILRES Training Center Operations & Personnel cost factor being considered, and being excluded from consideration. As with Total Savings, consideration of this single, ILRES cost factor, serves to remove the concern over low Annual Student Throughput Rate when considering an existing ILRES course for conversion

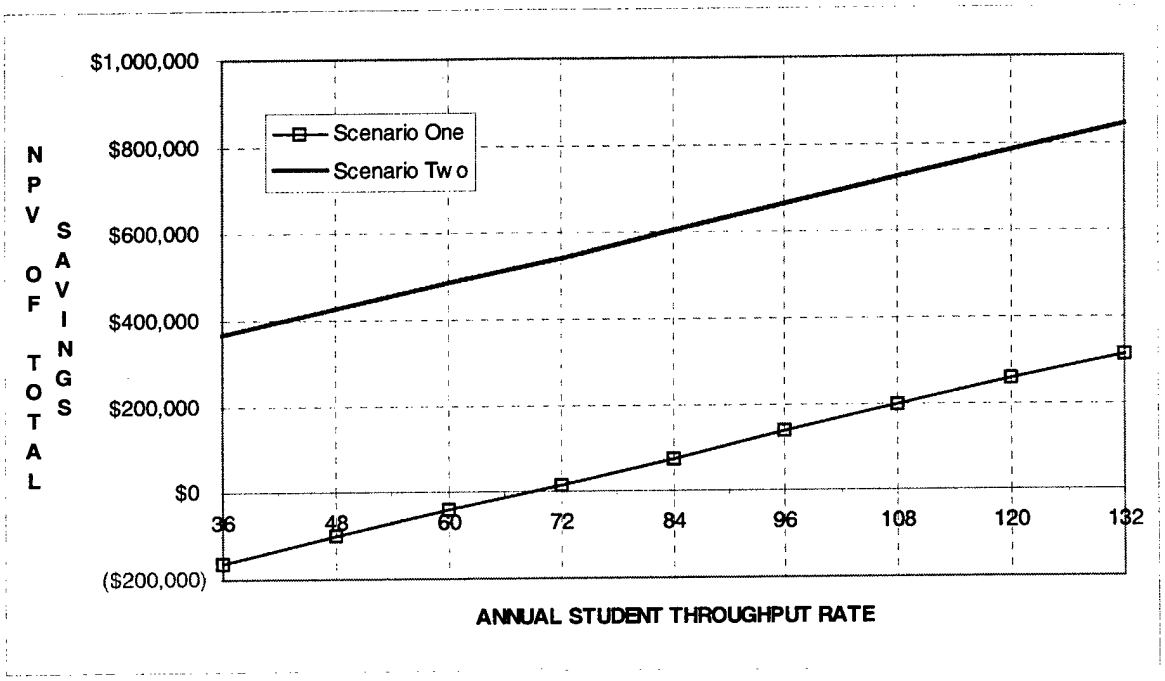

Figure 5-1 Effect on NPV of Total Savings, Based on Varying Rates of Annual Student Throughput

Based on a seven-year Course Life-span for the AN/WSC-3 course, a Discount Rate of 5.8 percent (refer to Table 5-4) was used in calculating the NPV of Total Savings. Figure 5-1 shows that at a Discount Rate of 5.8 percent, the NPV for Total Savings, for both Scenarios One and Two, are positive. Therefore, NPV of Total Savings supports investment in the NRCBT version of the course, based on an Annual Student Throughput Rate of 72 students. At 72 students, the Coast Guard would both recover the cost of the investment in converting the course, and the

required Rate-of-Return based on published Office of Personnel Management (OPM) requirements. However, if the Annual Student Throughput Rate for Scenario One were to drop below 69 students, NPV of Total Savings for Scenario One would not support investment in the NRCBT version of the course. In comparison, Total Savings for Scenario One is positive until the Annual Student Throughput Rate drops below 60 students. At 60 students, the USCG would recover its investment costs, but would not realize the published Rate-of-Return.

Figure 5-2 shows NPV of Total Savings, over a range of Discount Rates, from two (2) to 12 percent, for both Scenarios One and Two. Scenario One's NPV of Total Savings falls below $0 (zero) when the Discount Rate is greater than 7.42 percent. Therefore, NPV of Total Savings will not support investment in the NRCBT version of the course when Training Center Operations & Personnel is not considered, and the Discount Rate is above 7.42 percent. Scenario Two, which includes the Training Center Operations & Personnel cost factor, remains positive across the complete range of Discount Rates considered. Again, as with the results from the cost comparison, and the results for the sensitivity analysis for Scenario Two, the key insulating factor for savings was the consideration of the ILRES Training Center Operations & Personnel cost factor.

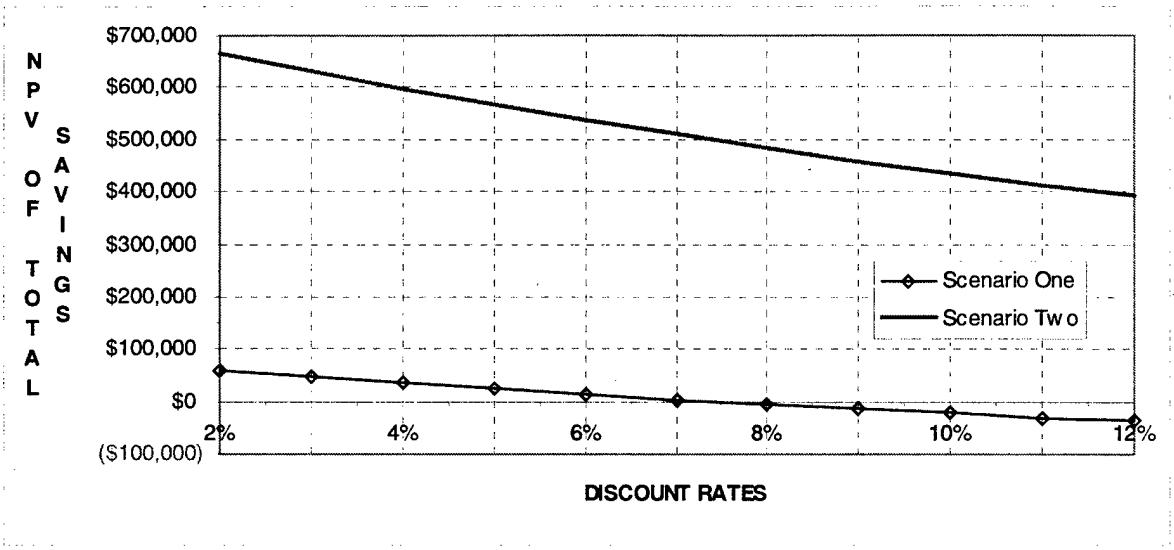

Figure 5-2 Effect on NPV of Total Savings, Based on Varying Discount Rates

Exploring Discount Rate And Training Center Operations & Personnel

A set of Cost Model runs were performed to demonstrate how changes in values used for the ILRES Training Center Operations & Personnel cost factor, combined with changes in the Discount Rate, would affect the NPV of Total Savings. Scenario Two was used as the basis for these model runs. In Scenario Two, the two NRCBT cost factors, Distribution Center Operations & Personnel and Student Support, are considered, regardless of whether or not the ILRES Training Center Operations & Personnel cost factor is set to $0 or greater.

Figure 5-3 shows NPV of Total Savings, over a range of Discount Rates, based on several levels of cost values for Training Center Operations & Personnel. As the graph in Figure 5-3 shows, even if the cost value entered for the ILRES Training Center Operations & Personnel cost factor were decreased by 50 percent of the base cost, the NPV of Total Savings would remain positive across the entire range of Discount Rates considered.

Table 5-5 lists the dollar values for NPV of Total Savings, based on three of the Discount Rates considered in the Cost Model runs. Table 5-5 also lists the dollar value for each level of Training Center Operations & Personnel costs considered. At a Discount Rate of nine percent, and with a 60 percent decrease in the cost value considered for Training Center Operations & Personnel, Table 5-5 shows a positive value of $5,340 for NPV of Total Savings. A positive value indicates that NPV of Total Savings will support investment in the NRCBT version of the course. A 60 percent decrease in the cost of training center operations and personnel, equates to $166.90 per training day per student, as opposed to the value used for this cost comparison effort, $430.34 per training day per student. This demonstrates that consideration of training center operations and personnel costs provides a large margin-for-error. Having a large margin-for-error should be important to the decision-maker, since any investment decision is based on estimates (educated guesses) of future events and costs.

Table 5-5 NPV of Total Savings, Based on Varying Discount Rates

		Discount Rates		
Annual Cost of Training Center Operations & Personnel	**Change in Cost Value**	**5%**	**7%**	**9%**
$ 150,206	**Base Cost**	$ 567,484	$ 510,271	$ 458,929
$ 120,165	**80 %**	$ 393,654	$ 348,370	$ 307,733
$ 90,123	**60 %**	$ 219,824	$ 186,469	$ 156,536
$ 60,082	**40 %**	$ 45,994	$ 24,567	$ 5,340
$ 30,041	**20 %**	($ 127,836)	($ 137,334)	($ 145,856)

A value of $0 for NPV of Total Savings indicates that the USCG has both recovered the investment costs for the NRCBT version of the course, and the Rate-of-Return required. The amount above $0 could be viewed as a remainder. That remainder, if large enough, could provide a source of funds for financing the development and implementation of the infrastructure, which will be required to support the successful implementation of nonresident training (e.g., interactive CBT, embedded training, correspondence) at the duty station. It may also provide funds that could be redirected to other needs at the discretion of USCG management, and the U.S. Federal Government.

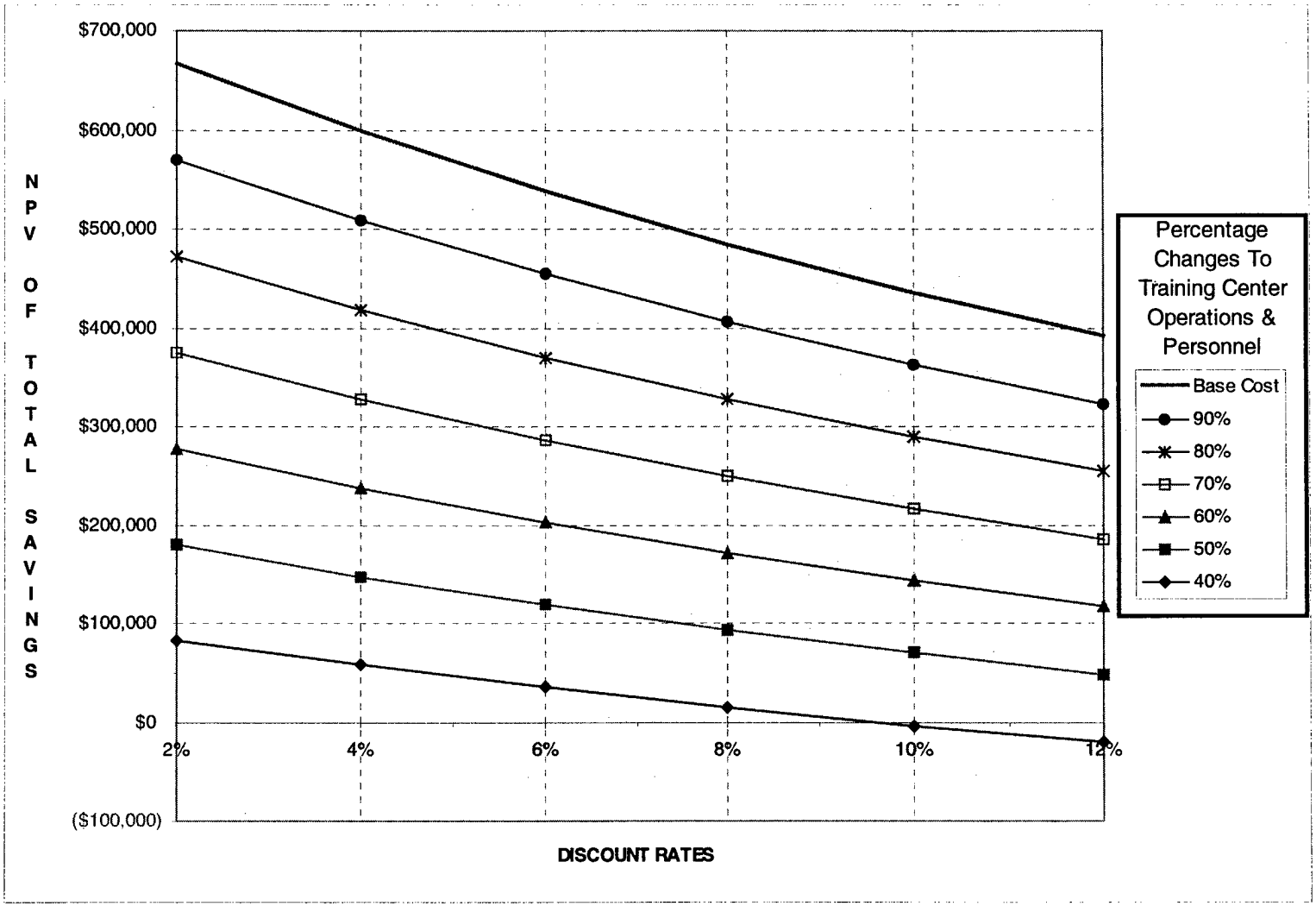

Figure 5-3 Effect to NPV of Total Savings, Based on Changes to Two Factors: Discount Rate and Training Center Operations & Personnel

5.4 EXAMPLE OF EXTRAPOLATING RESULTS OF COST COMPARISON TO LARGE SCALE COURSE CONVERSIONS IN USCG

Tables 5-6(a) and 5-6(b) present an extrapolation of NRCBT Annual Savings from the cost comparison analysis for Scenario Two, to NRCBT Annual Savings resulting from multiple ILRES course conversions in the USCG. The NRCBT Annual Savings estimates presented in these tables will not result in a gain to the USCG until the Pay-back Period for investment in the NRCBT version of the course(s) has been achieved. The difference between the two tables is the cost value considered for the ILRES Training Center Operations & Personnel cost factor. For Table 5-6(a), 100 percent of the value used for the Training Center Operations & Personnel cost factor (i.e., $430 per training week, per student) in Scenario Two is considered in calculating NRCBT Annual Savings. For Table 5-6(b), 50 percent of the value used for the Training Center Operations & Personnel cost factor (i.e., $215 per training week, per student) was applied in calculating NRCBT Annual Savings.

Within each of the two tables, NRCBT Annual Savings are presented based on the number of courses converted (i.e., 1, 5, 10, and 20 courses), relative to four levels of Annual Student Throughput Rate (i.e., 36, 72, 108, and 144 students). NRCBT Annual Savings, for each combination of Annual Student Throughput Rate and number of courses converted, is broken out further by NRCBT Annual Savings realized as the result of converting a one-week ILRES course, to an NRCBT version (referred to as "First Week"), then any additional NRCBT Annual Savings which may be realized as the result of a multiple-week ILRES course being converted (referred to as "For Each Additional Week"). The difference between these two categories is the cost factors considered. For example, ILRES Student Transportation is accounted for in calculating NRCBT Annual Savings for the category designated "First Week", and will not be counted for a second time in the calculation for the category "For Each Additional Week". Table 5-7 presents the cost factors considered in calculating each of these two categories.

Table 5-6(a) Extrapolating NRCBT Annual Savings ($K), Based on 100 Percent Consideration of ILRES Training Center Operations & Personnel Cost Factor Value

	SCEANRIO TWO AS BASIS, 100% OF TRAINING CENTER OPERATIONS & PERSONNEL CONSIDERED							
	NRCBT ANNUAL SAVINGS FOR CONVERSION OF ONE COURSE		NRCBT ANNUAL SAVINGS FOR CONVERSION OF FIVE COURSES		NRCBT ANNUAL SAVINGS FOR CONVERSION OF TEN COURSES		NRCBT ANNUAL SAVINGS FOR CONVERSION OF TWENTYCOURSES	
Annual Student Throughput Rate	First Week	Each Additional Week	First Week	Each Additional Week	First Week	Each Additional Week	First Week	Each Additional Week
36	$ 22	$ 67	$ 110	$ 335	$ 220	$ 670	$ 440	$ 1,340
72	$ 114	$ 154	$ 570	$ 770	$ 1,140	$ 1,540	$ 2,280	$ 3,080
108	$ 206	$ 240	$ 1,030	$ 1,200	$ 2,060	$ 2,400	$ 4,120	$ 4,800
144	$ 298	$ 326	$ 1,490	$ 1,630	$ 2,980	$ 3,260	$ 5,960	$ 6,520

Table 5-6(b) Extrapolating NRCBT Annual Savings ($K), Based on 50 Percent Consideration of ILRES Training Center Operations & Personnel Cost Factor Value

	SCEANRIO TWO AS BASIS, 50% OF TRAINING CENTER OPERATIONS & PERSONNEL CONSIDERED							
	NRCBT ANNUAL SAVINGS FOR CONVERSION OF ONE COURSE		NRCBT ANNUAL SAVINGS FOR CONVERSION OF FIVE COURSES		NRCBT ANNUAL SAVINGS FOR CONVERSION OF TEN COURSES		NRCBT ANNUAL SAVINGS FOR CONVERSION OF TWENTYCOURSES	
Annual Student Throughput Rate	First Week	Each Additional Week	First Week	Each Additional Week	First Week	Each Additional Week	First Week	Each Additional Week
36	($ 17)	$ 29	($ 85)	$ 145	($ 170)	$ 290	($ 340)	$ 580
72	$ 37	$ 76	$ 185	$ 380	$ 370	$ 760	$ 740	$ 1,520
108	$ 90	$ 124	$ 450	$ 620	$ 900	$ 1,240	$ 1,800	$ 2,480
144	$ 144	$ 171	$ 720	$ 855	$ 1,440	$ 1,710	$ 2,880	$ 3,420

Table 5-7 Cost Factors Considered in Calculating Each of the Two NRCBT Annual Savings Categories

FIRST WEEK		FOR EACH ADDITIONAL WEEK	
ILRES Course	**NRCBT Course**	**ILRES Course**	**NRCBT Course**
TC Operations & Personnel	DC Operations & Personnel	TC Operations & Personnel	DC Operations & Personnel
Student Transportation	Courseware Maintenance	Per Diem (At Training Center)	Courseware Maintenance
Per Diem (At Training Center)	Student Support	Student Time	Student Time
Per Diem (Travel Days)	Shipping of Course Materials		DS Facilitator Time
Student Materials	DS Facilitator Time		
Student Time	Student Materials		
	Student Time		

In performing the calculations for NRCBT Annual Savings, the values for three cost factors were modified. The ILRES Per Diem cost factor for student time spent at the training center was adjusted from four to seven days, when calculating the NRCBT Annual Savings for the category "For Each Additional Week". The change in days accounts for the weekend stay between training weeks. The NRCBT Student Time cost factor for both categories was modified from 13 hours to 20 hours. As stated in the sensitivity analysis for the NRCBT Student Time cost factor, most experts feel that a reduction in student time, as the result of moving to an NRCBT course, is in the range of 40 to 50 percent. NRCBT Duty Station Facilitator Time was bumped up from 4 to five hours to account for the additional student time.

Figure 5-4 demonstrates how the information presented in Tables 5-6(a) and 5-6(b) can be applied to estimate NRCBT Total Savings, as the result of multiple course conversions. In Figure 5-4, 22 ILRES courses with varying levels of Annual Student Throughput Rates, Course Life-spans after Pay-back Period has been achieved, and Course Lengths, are converted to an NRCBT variant. These 22 courses were randomly selected from course information published in a USCG publication, COMDTNOTE 1540. (Publication can be accessed at web site **www.uscg.mil/hq/reserve/pubs/1540/15toc.htm.**) The R&DC analysts used these courses to generate Annual Student Throughput Rates and Course Length data for the demonstration. The actual identities of the randomly selected courses have been changed in an attempt to avoid confusion with efforts by the USCG training community to identify ILRES courses for conversion to a nonresident form of training (e.g., interactive CBT, IVT, correspondence). It is important to note that in randomly selecting these courses, appropriateness for conversion to nonresident training, in any form, was not taken into consideration.

In the past, course life-spans of seven years or greater have been typical in the USCG training program. Course life-span being the period of time between implementation of the course in the USCG (in any form), to the course being completely eliminated from the USCG training program. The life-span of a course is dependent on the useful-life of a system or piece of

Course Identification	Annual Student Throughput Rate	Course Life-Span After Pay-back Period (Years)	Course Length (Weeks)	Partial Conversion (y/n)	100% Training Center Operations & Personnel		50% Training Center Operations & Personnel	
					NRCBT Annual Savings	NRCBT Total Savings Over Course Life-span	NRCBT Annual Savings	NRCBT Total Savings Over Course Life-span
AA-01	30	5	2	y	$ 83	$ 415	$ 7	$ 35
AA-02	18	7	1	n	22	154	(17)	(119)
AA-03	84	7	1	n	114	798	37	259
AA-04	30	7	2	y	83	581	7	49
AA-05	160	7	2	y	601	4,207	291	2,037
AA-06	50	7	1	n	22	154	(17)	(119)
AA-07	100	7	1	n	206	1,442	90	630
AA-08	24	7	1	n	22	154	(17)	(119)
AA-09	180	7	2	y	601	4,207	291	2,037
AA-10	60	7	1	n	114	798	37	259
AA-11	50	3	1	n	22	66	(17)	(51)
AA-12	35	7	1	n	22	154	(17)	(119)
AA-13	70	7	3	y	411	2,877	177	1,239
AA-14	50	7	2	n	89	623	12	84
AA-15	8	7	2	n	89	623	12	84
AA-16	36	7	1	n	22	154	(17)	(119)
AA-17	150	7	1	n	298	2,086	144	1,008
AA-18	25	7	1	n	22	154	(17)	(119)
AA-19	90	7	3	n	422	2,954	189	1,323
AA-20	92	7	1	y	103	721	25	175
AA-21	60	7	1	n	114	798	37	259
AA-22	150	7	4	n	1,276	8,932	70	490
				SAVINGS TOTAL ==>	$ 4,758	$ 33,052	$ 1,307	$ 9,203

Figure 5-4 Demonstration of Extrapolating Cost Comparison Results ($K)

equipment to the USCG. For purposes of the demonstration, with the exception of two courses listed in Figure 5-4, the Course Life-span factor was set to seven years.

Six multiple-week courses listed in Figure 5-4 have been designated as having been partially converted to NRCBT. For example, a five-week ILRES course might be partially converted to 2 weeks of NRCBT, and the remaining three weeks continue to be ILRES. When a partial conversion is considered, the NRCBT Annual Savings for that course is calculated using the following two steps:

1. The number-of-weeks converted is multiplied by the relevant "For Each Additional Week" value presented in either Table 5-6(a), or Table 5-6(b).
2. Since the dollar value for the category, "For Each Additional Week", does not account for the Student Support cost factor when taken alone (i.e., partial conversion which will still require student transportation for part of course remaining ILRES), the value for the Student Support cost factor used in Scenario Two (i.e., $51K) is subtracted from the result of Step (1). The result of Step (2) is the NRCBT Annual Savings which results from the partial conversion of the existing ILRES course, to an equivalent, NRCBT version.

In reviewing the results presented in Figure 5-4, a 100 percent consideration of the value used for the Training Center Operations & Personnel cost factor results in a positive NRCBT Annual Savings, across all non-cost factor ranges considered. This is not the case when the value used for the Training Center Operations & Personnel cost factor is reduced by 50 percent. As Table 5-6(b) shows, when a one-week ILRES course with an Annual Student Throughput Rate of 36 students is converted to an equivalent, NRCBT version, the result is a loss, rather than a savings. However, if enough courses are converted which result in a positive NRCBT Annual Savings, as demonstrated in Figure 5-4, it is still possible to save millions-of-dollars per year.

Table 5-8 presents the results of applying NPV to the NRCBT Annual Savings streams for each of the 22 courses referred to in Figure 5-4. The results of applying NPV supports the investment in all 22 courses when 100 percent of the value for the Training Center Operations & Personnel cost factor is considered. When the value used for the Training Center Operations & Personnel cost factor is reduced by 50 percent, investment in conversion of seven of the courses is not supported by the results from applying NPV. Conversion of these seven courses was also not supported by the results from the Capital Expenditure Analysis data point NRCBT Total Savings.

Table 5-8 NPV Applied to Results from Extrapolation Demonstration ($K)

COURSE IDENTIFICATION	100% OF TC OPERATIONS & PERSONNEL	50% OF TC OPERATIONS & PERSONNEL
AA-01	$ 352	$ 30
AA-02	124	(96)
AA-03	641	208
AA-04	467	39
AA-05	3,379	1,636
AA-06	124	(96)
AA-07	1,158	506
AA-08	124	(96)
AA-09	3,379	1,636
AA-10	641	208
AA-11	59	(46)
AA-12	124	(96)
AA-13	2,311	995
AA-14	500	67
AA-15	500	67
AA-16	124	(96)
AA-17	1,675	810
AA-18	124	(96)
AA-19	2,373	1,063
AA-20	579	141
AA-21	641	208
AA-22	7,174	394
NPV OF TOTAL SAVINGS	**$ 26,572**	**$ 7,388**

6 CONCLUSIONS

Nonresident CBT Is Cost Effective

Conversion of existing ILRES courses, to an equivalent NRCBT version, can be cost effective. The final results of the effectiveness evaluation, which are presented in the "Training Technologies Pilot Study: Non-resident Computer Based Training Effectiveness Evaluation (Final Report)" report, show that a quality, NRCBT version of a course can be equally effective to the ILRES version of the same course. This shows that NRCBT has the potential to save training dollars.

Scenario Two Is Optimal Choice

For the one-week ILRES course considered, both Total Savings and NPV of Total Savings, presented in Table 6-1, support investment in the NRCBT version of the course. However, the optimal choice is Scenario Two, as Pay-back Period is decreased by 65 percent, and Total Savings are eight times as great as Total Savings calculated for Scenario One. Scenario Two is the conversion of a "meaningful" number of ILRES courses, to a nonresident version delivered to students at their duty stations.

Table 6-1 Comparison of Total Savings for Scenarios One and Two

SCENARIO	TRAINING CENTER OPERATIONS & PERSONNEL		TOTAL SAVINGS OVER 7 YEARS	NPV OF TOTAL SAVINGS
One	Not Considered		$ 84K	$ 4K
Two	Considered		$ 742K	$ 544K

Most Important Single Cost Factor Consideration Is Training Center Operations & Personnel

Consideration of the ILRES Training Center Operations & Personnel cost factor is important for the following reasons:

1. Minimizes Annual Student Throughput Concerns

Consideration of the ILRES Training Center Operations & Personnel cost factor (Scenario Two) minimizes concerns regarding low Annual Student Throughput Rates. For example, when the ILRES cost factor was considered in this analysis (refer to section 4.3.1.1), a savings is realized even when the Annual Student Throughput Rate falls to zero. If this ILRES cost factor is not considered (Scenario One), then an Annual Student Throughput Rate of 60 students or more is required for Total Savings to support investment in the NRCBT version. NPV of Total Savings, using a Discount Rate of 5.8 percent, requires an Annual Student Throughput Rate of 69 students or more when costs associated with the operation and staffing of a resident training center are not considered.

2. Significantly Decreases Pay-back Period

The further into the future the Pay-back Period is extended, the greater the risk that an unforeseen event, such as a technological advance, will eliminate the need for the system being trained before the Pay-back Period is reached. Inclusion of the ILRES Training Center Operations & Personnel cost factor (Scenario Two), when compared to the complete exclusion of this cost factor (Scenario One), results in a decrease in Pay-back Period of 65 percent, and thereby, a reduction in risk in making the investment.

3. Dramatically Increases Savings Potential

Regardless of whether Total Savings or NPV of Total Savings is considered, there is a dramatic increase in savings potential when the ILRES Training Center Operations & Personnel cost factor is included in the cost comparison analysis. The difference in savings potential between inclusion and exclusion of this single cost factor, provides three important advantages to the decision maker:

a) A margin-for-error and a source of funds for reinvestment to infrastructure. A margin-for-error is important to the decision-maker as any decision regarding investment is based on estimations of future events and costs.
b) An infrastructure will need to be developed and deployed by the USCG, to support the successful implementation of nonresident training delivered at the duty station. The increased savings potential provides a source of funds which could be reinvested into development and implementation of the required infrastructure, and still have funds remaining which could be used by the USCG to meet other mission needs as well.
c) A media mix can cost twice as much, and still provide room for substantial savings.

Seven Important Factors When Considering Training Costs

Based on the results of the Sensitivity Analysis reported in section 4.3 (Sensitivity Analysis Model Runs), the seven factors listed in Table 6-2 will have the greatest affect on costs for both the ILRES and NRCBT versions of a course. Three of the factors are non-cost factors, which apply to both the ILRES and NRCBT sides of the cost comparison.

Table 6-2 Seven Important Factors When Considering Training Costs

FACTOR	FACTOR TYPE	COST TYPE
Annual Student Throughput Rate	Non-cost	Generic
Course Life-span	Non-cost	Generic
Course Length	Non-cost	Generic
TC Operations & Personnel	Cost	ILRES
Student Transportation	Cost	ILRES
CBT Design & Development	Cost	NRCBT
Student Support	Cost	NRCBT

Consideration Of ILRES Cost Factors Classroom & Lab Equipment, And Classroom & Lab Space, Can Offset CBT Development Costs

The consideration of the ILRES cost factors, Classroom & Lab Space and Classroom & Lab Equipment, can significantly offset investment costs to convert and implement an equivalent, nonresident version of a course, and thereby, greatly increase savings potential. For an existing ILRES course, these cost factors can only be considered if there is an opportunity to recoup money spent to purchase the space and/or equipment, or if a situation occurs where a cost avoidance opportunity may be considered (e.g., relocation of the ILRES course which requires procurement of space).

7 RECOMMENDATIONS

This cost comparison should be considered a first step. The next step is to identify the existing ILRES courses taught at resident training centers, both inside and outside the USCG, which have the potential to be converted to an alternative nonresident training delivery method. Of the

courses identified as potential candidates for conversion, a detailed analysis would be performed to determine the appropriateness of converting the existing ILRES course, and to determine the media mix for delivery of the nonresident version of each course deemed appropriate for conversion.

Once the media selection process has been completed, cost data would be collected for each of the existing ILRES courses deemed appropriate for conversion, and estimations made for the cost of an equivalent nonresident version. A cost analysis would then be performed to determine the overall savings potential, as a group (set), of the selected ILRES courses. Part of that cost analysis would involve determining if conversion of the complete set of selected ILRES courses would result in a reduction of resident training operations and staffing costs.

In addition to identifying the ILRES courses for possible conversion, a parallel effort should involve the following tasks:

1. Determine what an adequate infrastructure system to support nonresident training at the duty station should look like. This can be done by accessing the USCG work environment, exploring infrastructure systems which have been employed by organizations outside the USCG (both public and private), and performing a literature review. Exploration of infrastructures should include both those deemed successful, and those deemed to have been failures.

2. Select one or two infrastructure systems that may apply to USCG needs, and its work environment. If no system is found from outside the USCG, then develop a blueprint (concept) of an infrastructure for the USCG from scratch, based on what was learned from accessing the infrastructures of outside organizations, and from accessing the USCG work environment and mission requirements. In selecting or envisioning an infrastructure system for the USCG, the types of courses selected for conversion to a nonresident version, and the media mix which will be used to deliver each of the nonresident courses to students at their duty stations, needs to be taken into account.

3. Create a timeline for development of the infrastructure system, and for implementing the infrastructure within the USCG training program.

4. Perform a cost estimate to determine what full-scale development and implementation will cost. Full scale development and implementation will most likely require the following effort:

a) Development of the infrastructure, or if an infrastructure from an outside organization has been selected, make the necessary modification for application to USCG needs and requirements.

b) Test the system in a limited area of the USCG, to evaluate and fine tune, before considering implementation USCG wide. During the development and testing phases, measures and tools would be generated, by which, both the infrastructure

system and the nonresident courses could be monitored and analyzed for effectiveness. This would provide the USCG with an evolving method to ensure that the nonresident training program, both infrastructure and nonresident courses, are continually cost effective in addressing USCG needs and mission requirements.

c) Implementation of an infrastructure system in USCG. System is monitored and analyzed continually to ensure cost effectiveness. Life-cycle costs of infrastructure will also need to be estimated.

5. Perform a cost analysis, which includes costs for both development, and implementation, of the infrastructure envisioned.

Upon completion of both efforts, a comparison of costs should be performed to determine whether or not conversion of the selected ILRES courses would result in an overall savings that meets, or exceeds, that desired by USCG management.

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APPENDIX A

DETAILED DESCRIPTION OF THE COST MODEL

Appendix A provides a detailed description of the inner workings of the Cost Model. The first part of the Appendix describes the three data sheets which make up the Cost Model. The second part of the Appendix presents the embedded formulas used to generate results for the Cost Model runs.

Although the Cost Model was developed as a tool to perform the pilot study's cost comparison analysis, the use of the concepts presented in this model are not limited to a comparison of ILRES with an equivalent NRCBT version. These concepts can also be used to compare ILRES versions of courses with any media mix being considered as an alternative method of delivering those courses. If the measures for the cost of not training were available, the concepts presented in this model could be used to delineate between several training options.

Copies of the Cost Model can be obtained from the R&DC upon request. Those receiving a copy of the model are free to embellish the model as they see fit. The password to obtain modification capabilities is **USCG**. The password is also listed in the data sheet "Info Sheet".

A.1 COST MODEL DATA SHEETS

A.1.1 DATA SHEET NAME: "DATA INPUT"

This data sheet is the location where the user inputs data into the Cost Model. The data provided by the user will be used to drive Cost Model runs. Data cells where the user must input data are highlighted with a light green background. For some cost factors (e.g., ILRES Student Time cost factor), the user enters values for various parameters (e.g., Hours, Hourly Rate) associated with a cost factor. These parameter values will then be used by the Cost Model to calculate the value of the relevant cost factor. For other cost factors (e.g., ILRES Student Transportation cost factor), the user enters the value for the cost factor directly into the Cost Model.

An exception to this data entry scheme is when cost factors Training Center Operations & Personnel (ILRES cost factor) and Distribution Center Operations & Personnel (NRCBT cost factor) are to be treated as O&M Costs for a particular Cost Model run. When treated as an O&M Cost, parameter values (e.g., ILRES Course Length, Student Throughput) for these two cost factors would be entered in data cells highlighted with a dark green background. The dark green background color serves as a reminder to the user of the unique way in which the cost for these two cost factors are calculated and applied in the Cost Model. When these two cost factors are entered as an O&M Cost, both cost factors are calculated based on the number of students who were scheduled to take the course in the Fiscal Year for which cost and personnel data was obtained. The values calculated for these two cost factors are then treated as constants (do not change) as various sets of Capital Expenditure data points are generated for each Annual Student Throughput Rate considered.

Values generated by the Cost Model with a white background. Data cells containing values which will be accessed by other Cost Model data sheets are outlined in black.

The data sheet "Data Input" is divided into three sections. The first section is for input data related to generic information. The second section is for input data specific to generating costs for operation of the NRCBT version of the course. The third section is for input data specific to generating costs for operation of the ILRES version of the course. The types of information required from the user for each of these sections are listed in Tables A-1, A-2, and A-3, respectively. Each table lists the factors, and where required, the associated parameters, for which data input from the user is required. In addition, each table lists the relative units, and the data values which were used in making Cost Model runs for this cost comparison analysis.

Table A-1 Generic Input Data to be Entered by the User

FACTORS AND PARAMETERS	UNITS	DATA VALUES ENTERED
Annual Student Throughput Rate	Students	72
Course Life-span	Years	7
Discount Rate	Percentage	7
Data Drivers For Creating Tables		
Start Point For Student Throughput Consideration	Students	36
Student Interval	Students	12
Training Weeks Per Year	Weeks	50
Calculating Computer Requirements (Nonresident)		
Time To Ship To Student	Weeks	1
Time Period To Complete Training	Weeks	2
Time To Return Materials	Weeks	1
Handling Time At Distribution Center	Weeks	1
Calculating Additional Instructors (Resident)		
Prep Time Before Class Convenes	Days	2
Length Of Class	Days	5
Maximum Students Per Class	Students	6
Instructor Salary	Per Instructor	$47,493
Calculating Additional Transceivers (Resident)		
Length Of Class	Weeks	1
Current Transceiver Inventory		
Total Inventory	Unit	9
Number Used As Spares	Unit	3

Table A-2 NRCBT Cost Data to be Entered by the User

NRCBT DATA ENTRY REQUIREMENTS		
COST FACTORS AND ASSOCIATED PARAMETERS	**UNITS**	**DATA VALUES ENTERED**
ISD Process	Dollars	$0.00
CBT Design/Development		
CBT Instructional Hours	Hours	10
Cost-per-hour	Dollars	$19,000
SME Support Design & Development		
Primary SME		
Time	Hours	1440
Hourly Rate	Dollars	$24.51
Secondary SME		
Time	Hours	100
Hourly Rate	Dollars	$27.23
SME Travel Costs	Dollars	$5,000
Equipment for Course Distribution		
Laptop Computers	Unit Cost	$4,000
Shipping Case	Unit Cost	$152
Courseware Maintenance	Percentage	10%
Student Support (e.g., Help Desk)	Dollars	$50,976
Distribution Center Operations & Personnel		
Student Throughput	Students	72
Cost Per Day Per Student	Dollars	$73.37
Shipping Materials		
Send Materials To Duty Station	Dollars	$36
Return Materials To Distribution Center	Dollars	$36
Student Materials	Dollars	$20
Student Time		
Time	Hours	13
Hourly Rate	Dollars	$18.25
Facilitator Time		
Time	Hours	4
Hourly Rate	Dollars	$24.51

Table A-3 ILRES Cost Data to be Entered by the User

ILRES DATA INPUT REQUIREMENTS		
COST FACTORS AND ASSOCIATED PARAMETERS	**UNITS**	**DATA VALUES ENTERED**
ISD Process	Dollars	$0.00
USCG SME Support (For ISD Process)		
Primary SME		
Time	Hours	0
Hourly Rate	Dollars	$0.00
Secondary SME		
Time	Hours	0
Hourly Rate	Dollars	$0.00
SME Travel Costs	Dollars	$0.00
Classroom & Lab Space	Dollars	$176,000
Classroom & Lab Equipment		
AN/WSC-3 UHF Transceivers		
Inventory Of Transceivers	Number	9
Cost Per Unit	Dollars	$35,000
Peripheral (Supporting) Equipment	Dollars	$187,000
Training Center Operations & Personnel		
Resident Course Length	Days	5
Student Throughput	Students	72
Cost Per Training Day Per Student	Dollars	$430.34
Student Time		
Time	Hours	40
Hourly Rate	Dollars	$18.25
Student Transportation	Dollars	$500
Student Materials	Dollars	$65.50
PER DIEM (Meals & Incidental Expenses)		
At Training Center		
Duration (time)	Days	4
Daily Rate	Dollars	$11
On Travel Days		
Percentage Of Per Diem Paid To Student	Percentage	75%
Duration (time)	Days	2
Daily Rate	Dollars	$32

A.1.2 DATA SHEET NAME: "COMPUTERS"

This data sheet calculates three cost values:

1. Cost of laptop computers and shipping cases required based on the Annual Student Throughput Rate considered. The value calculated is for the NRCBT Equipment For Course Distribution cost factor.
2. Cost of additional instructors required based on the Annual Student Throughput Rate considered. The value calculated is part of the ILRES Training Center Operations & Personnel cost factor.
3. Cost of additional AN/WSC-3 UHF transceivers based on the Annual Student Throughput Rate considered. The value calculated is part of the ILRES Classroom & Lab Equipment cost factor.

These three values are contained in a set. A set is generated for each Annual Student Throughput Rate considered in a Cost Model run. Each set of costs generated are presented in a table located in data sheet "Computers".

When this model was first conceptualized, only the calculation for computer requirements, based on the Annual Student Throughput Rate, was considered. As the model evolved over time, additional formulas were developed to account for additional instructors and additional AN/WSC-3 UHF transceivers based on varying Annual Student Throughput Rates. If this cost model is used beyond this cost comparison effort, the name of this data sheet should be changed.

A.1.3 DATA SHEET NAME: "TABLES"

This data sheet is divided into two sections. The first section consists of two tables. Each table, which is associated with a particular scenario considered in the Cost Model run, contains several sets of Capital Expenditure data points. Various levels of Annual Student Throughput Rates are considered for each of the two scenarios contained in the Cost Model. Therefore, for each level of Annual Student Throughput Rate, a corresponding set of Capital Expenditure data points are generated by a Cost Model run. These Capital Expenditure data points include Pay-back Period (break-even point), Rate-of-Return, Annual Cost Avoidance, Total Savings (Based on Course Life-span), and Net Present Value (NPV) of Total Savings. The Capital Expenditure data points Pay-back Period and Total Savings are discussed in the main body of this report, section "cost comparison Methodology". Capital Expenditure data points Rate-of-Return, Annual Cost Avoidance, and Net Present Value of Total Savings are discussed in Appendix B of this report.

The second section lists the cost factor values which will be used in the Cost Model run, based on the scenario being considered. Two scenarios are addressed in the Cost Model, and are referred to as Scenarios One and Two. Scenario One is the replacement of a single existing ILRES course. Scenario Two is the replacement of a "meaningful" number of existing ILRES courses which allows for costs associated with operation and staffing of a training center to be considered in the analysis. The values listed, in combination with the appropriate values listed in

the table presented in data sheet "Computers", will be used by various formulas contained in section one of this data sheet, to generate the sets of Capital Expenditure data points.

A.2 FORMULAS

This part of the Appendix will present formulas used in calculating various data points in the Cost Model. All formulas contained in data sheet "Data Input" are used to generate cost factor values, when required. As stated earlier in this Appendix, some of the cost factor values are entered directly by the user into the Cost Model, and did not require generation of the cost factor value by the Cost Model.

All formulas contained in data sheet "Computers" are used to generate sets of data points regarding laptop computer costs (NRCBT), additional instructors costs (ILRES), and additional AN/WSC-3 UHF transceivers costs (ILRES). Each set of data points are generated based on an Annual Student Throughput Rate. Each set of data points were then stored in a table, which is presented in data sheet "Computers".

All formulas contained in data sheet "Tables" are used to generate sets of Capital Expenditure data points. Each set of data points are generated based on an Annual Student Throughput Rate. Each set of data points, which are the results of the Cost Model run, are then stored in one of two tables. The two tables are presented in data sheet "Tables". For the cost comparison analysis performed for the pilot study, the first table was for Cost Model results relative to cost factor considerations of Scenario One, and the second table was for results relative to cost factor considerations of Scenario Two.

A.2.1 DATA SHEET NAME: "DATA INPUT"

A.2.1.1 NRCBT Costs

A.2.1.1.1 USCG Subject Matter Expert Support

This formula is divided into three parts. The first part calculates the cost of the primary subject matter expert (SME). The second part calculates the cost of the secondary SME. The final part sums the results of parts one and two, with SME travel costs.

[Part One: Calculate Primary SME cost]
Primary SME Costs = (Primary SME Hours * Primary SME Hourly Rate)

[Part Two: Calculate Secondary SME cost]
Secondary SME Costs = (Secondary SME Hours * Secondary SME Hourly Rate)

[Part Three: Calculate Cost Factor]
USCG Subject Matter Expert Support = Primary SME Costs + Secondary SME Costs + SME Travel Cost)

A.2.1.1.2 CBT Design & Development

CBT Design & Development = CBT Instruction Hours * Cost Per CBT Hour of Instruction

A.2.1.1.3 Courseware Maintenance

Courseware Maintenance = Courseware Maintenance Percentage * CBT Design & Development

A.2.1.1.4 Distribution Center Operations & Personnel

Calculation of this data point is only required when treated as an O&M Cost. When treated as a Per Student Cost, the value for the cost factor is entered by the user directly into the Cost Model.

Distribution Center Operations & Personnel = Student Throughput for FY Considered * Cost Per Day Per Student

A.2.1.1.5 Student Time

Student Time = Student Time * Student Hourly Rate

A.2.1.1.6 Duty Station Facilitator Time

Duty Station Facilitator Time = Facilitator Time * Facilitator Hourly Rate

A.2.1.2 ILRES Costs

A.2.1.2.1 USCG Subject Matter Expert Support

This formula is divided into three parts. The first part calculates the cost of the primary SME. The second part calculates the cost of the secondary SME. The final part sums the results of parts one and two, with SME travel costs.

[Part One: Calculate Primary SME cost]
Primary SME Costs = (Primary SME Hours * Primary SME Hourly Rate)

[Part Two: Calculate Secondary SME cost]
Secondary SME Costs = (Secondary SME Hours * Secondary SME Hourly Rate)

[Part Three: Calculate Cost Factor]
USCG Subject Matter Expert Support = Primary SME Costs + Secondary SME Costs + SME Travel Cost)

A.2.1.2.2 Classroom & Lab Equipment

This formula calculates the cost of the existing classroom and lab equipment. The cost of any additional equipment required based on Annual Student Throughput Rate is calculated elsewhere. This formula is divided into two parts. The first part calculates the cost of the AN/WSC-3 UHF transceivers. The second sums the result from part one with peripheral equipment.

[Part One: Calculate Total Cost Of AN/WSC-3]
Cost Of Transceivers = Inventory Of Transceivers * Transceiver Cost Per Unit

[Part Two: Calculate Cost Factor]
Classroom & Lab Equipment = Cost Of Transceivers + Peripheral Equipment Cost

A.2.1.2.3 Training Center Operations & Personnel

Treated As O&M Cost

Training Center Operations & Personnel = Resident Course Length *
Student Throughput for FY Considered * Cost Per Training Day Per Student

Treated As Per Student Cost

Training Center Operations & Personnel = Resident Course Length *
Cost Per Training Day Per Student

A.2.1.2.4 Student Time

Student Time = Student Time * Student Hourly Rate

A.2.1.2.5 Per Diem

This cost factor is calculated in three parts. The first part calculates Per Diem costs while at the training center. Note, time at the training center is course length minus one day (refer to section "Data Collection And Validation", which is contained in the main body of this report). The second part calculates Per Diem while in transit between the duty station and the training center. The final part sums the result of part one and with the sum of part two.

[Part One: Calculate Per Diem While At Training Center]
Per Diem While At Training Center = Duration Time * Per Diem At Training Center

[Part Two: Calculate Per Diem While In Transit]
Per Diem On Travel Days = (Per Diem In Transit * Percentage Of Per Diem Paid To Student) * Transit Days

A.2.2 DATA SHEET NAME: "COMPUTERS"

A.2.2.1 Equipment For Course Distribution (Investment Cost)

This formula is divided into two parts. The first calculates the number of computers required based on the Annual Student Throughput Rate and the second calculates the total cost.

[Part One: Calculate Computer Requirement]
Computers Required = (Annual Student Throughput Rate * SUM(shipping to student, return shipping to distribution center, training period, handling at distribution center and miscellaneous)) DIVIDED BY Training Weeks In Year

[Part Two: Calculate total cost]
Equipment for Course Distribution = (result from Part One * (Laptop Computer Per Unit Cost + Shipping Case Per Unit Cost))

A.2.2.2 Additional Resident Instructor (O&M Cost)

This formula is divided into two parts. The first part calculates the number of additional instructors required based on Annual Student Throughput Rate. The second part calculates the cost for the addition instructor(s).

[Part One: Calculate Additional Instructors Required]
Additional Instructors Required = Floor(((Annual Student Throughput Rate / Maximum Students Per Class) * (Class Prep Time + Length Of Class)) / (Training Weeks In Year * Training Days In Week)), 1)

[Part Two: Calculate Total Cost]
Additional Resident Instructor = Additional Instructors Required * Per Instructor Cost

A.2.2.3 Additional AN/WSC-3 UHF Transceivers (Investment Cost)

This formula is divided into two parts. The first part calculates the number of additional AN/WSC-3 UHF transceivers required based on Annual Student Throughput Rate. The second part calculates the cost for the additional AN/WSC-3 UHF transceivers.

[Part One: Calculate Additional WSC-3 Transceivers Required]
IF Annual Student Throughput Rate IS LESS THAN OR EQUAL TO ((Transceiver Inventory - Transceiver Spares) * Training Weeks In Year) THEN

Additional Transceivers Required = zero
[There are enough transceivers to cover annual student throughput needs]

ELSE

Additional Transceivers Required = (Ceiling((Annual Student Throughput Rate - ((Transceiver Inventory - Transceiver Spares) * Training Weeks In Year)) / Training Weeks In Year, 1)

[End Of Statement]

[Part Two: Calculate Total Cost]
Additional AN/WSC-3 UHF Transceivers = Additional Transceivers Required * Per Unit AN/WSC-3 UHF Transceiver Cost

A.2.3 DATA SHEET NAME: "TABLES"

A.2.3.1 Pay-back Period

IF annual savings GREATER THAN zero THEN

IF(nonresident investment + nonresident annual) LESS THAN OR EQUAL TO (resident investment + resident annual) THEN

Pay-back Period = zero

ELSE

IF ((nonresident investment - resident investment) + (nonresident annual - resident annual)) GREATER THAN (resident per student costs based on considered annual student throughput rate - nonresident per student costs based on considered annual student throughput rate) THEN

Pay-back Period = (nonresident investment - resident investment) DIVIDED BY ((resident annual + resident per student costs based on considered annual student throughput rate)-(nonresident annual + nonresident per student costs based on considered annual student throughput rate)

ELSE

Pay-back Period = (nonresident investment - resident investment) + (nonresident annual - resident annual) DIVIDED BY (resident per student costs based on considered annual student throughput rate - nonresident per student costs based on considered annual student throughput rate)
ELSE

Pay-back Period = "Note A"

[End Of Statement]

Note A is the result when Annual Cost Avoidance (annual savings) is less than, or equal to zero. The R&DC analyst did not have time to develop a calculation to handle this situation. Interesting enough, although there may be no annual savings, the investment cost differences may warrant investment in the nonresident alternative, but this dependent on Course Life-span in relation to the point in time at which a negative Total Savings would occur.

A.2.3 Rate-of-Return

IF Pay-back Period EQUALS zero THEN

Rate-of-Return = "Note B"

ELSE

IF (Resident Per Student Cost - Nonresident Per Student Cost) IS GREATER THAN zero THEN

Rate-of-Return = Annual Cost Avoidance DIVIDED BY Nonresident Investment Costs

ELSE

Rate-of-Return = "Nil"

[End Of Statement]

A.2.3.3 Annual Cost Avoidance

Annual Cost Avoidance = (Annual Student Throughput Rate * (Resident Per Student Costs - Nonresident Per Student Costs)) + (Resident O&M Costs - Nonresident O&M Costs)

A.2.3.4 Total Savings

Total Savings = (Course Life-span * Annual Cost Avoidance) - (Nonresident Investment Costs - Resident Investment Costs)

A.2.3.5 Net Present Value Of Total Savings

This formula is presented, for ease of understanding to the reader, in two parts. The first part describes the formula. Net Present Value (NPV) is calculated through use of a function provided in Microsoft Excel ®. This function requires the Discount Rate to be considered, and a series of total savings values for each of the years considered. The total dollar value returned for the series of dollar values provided the function, is then subtracted from the difference between

Investment Costs of the nonresident CBT and instructor-led resident versions of the course. The second part describes the calculation of total savings for each year considered.

[Part One: Overall Formula Used]
NPV Of Total Savings = Net Present Value(Discount Rate, Series Of Savings Each Year) MINUS (Nonresident Investment Costs - Resident Investment Costs)

[Part Two: How Savings For Each Year Considered Is Calculated]
IF Course Life-span IS GREATER THAN OR EQUAL TO year considered THEN

Savings In Year Considered = ((Resident Per Student Costs * Annual Student Throughput Rate) + Resident O&M Costs) - ((Nonresident Per Student Costs * Annual Student Throughput Rate) + Nonresident O&M Costs)

ELSE

Savings In Year Considered = zero

[End Of Statement]

APPENDIX B

RESULTS OF COST COMPARISON (SCENARIOS ONE AND TWO)

Appendix B provides the results for all Capital Expenditure Analysis data points which were generated in Cost Model runs for Scenarios One and Two. The Capital Expenditure Analysis data points are Pay-back Period, Rate-of-Return, Annual Cost Avoidance, Total Savings, and Net Present Value of Total Savings. Formulas used in the Cost Model to generate these data point values are presented in Appendix A. Discount Rate used for calculating NPV of Total Savings presented in Tables B-1 and B-2 was 5.8 percent based on rates for January 1998 published in OMB Circular Number A-94. Table B-1 presents the set of data point values generated for each level of Annual Student Throughput Rate considered in the Cost Model run for Scenario One. Table B-2 presents the set of data point values generated for Scenario Two.

In reviewing Tables B-1 and B-2, the reader will notice significant increases in dollar values between Annual Student Throughput Rates of 204 and 216 students, and again, between 300 and 312 students. Above 204 students per year, an additional instructor is required for the ILRES course based on data input to the Cost Model. Above 300 students per year, an additional AN/WSC-3(v)7 UHF transceiver is required for the ILRES course based on data input to the Cost Model.

Table B-1 Scenario One Results

Annual Student Throughput Rate	Pay-Back Period (in years)	Rate-of-Return (first year)	Annual Cost Avoidance	Total Savings (7 years)	NPV of Total Savings (5.8 %)
36	16.03	6 %	$ 15,567.56	($ 140,652)	($ 162,100)
48	9.37	10 %	$ 27,090.08	($ 64,147)	($ 101,469)
60	6.68	14 %	$ 38,612.60	$ 12,359	($ 40,838)
72	5.31	18%	$ 50,135.12	$ 84,712	$ 15,640
84	4.39	22 %	$ 61,657.64	$ 161,218	$ 76,271
96	3.75	26 %	$ 73,180.16	$ 237,724	$ 136,902
108	3.29	30 %	$ 84,702.68	$ 314,229	$ 197,533
120	2.94	34 %	$ 96,225.20	$ 390,735	$ 258,164
132	2.70	37 %	$ 107,747.72	$ 463,089	$ 314,643
144	2.48	40 %	$ 119,270.24	$ 539,594	$ 375,274
156	2.29	43 %	$ 130,792.76	$ 616,100	$ 435,905
168	2.13	46 %	$ 142,315.28	$ 692,606	$ 496,535
180	2.00	49 %	$ 153,837.80	$ 769,111	$ 557,166
192	1.91	52 %	$ 165,360.32	$ 841,465	$ 613,645
204	1.81	55 %	$ 176,882.84	$ 917,970	$ 674,276
216	1.38	72 %	$ 235,898.36	$ 1,326,927	$ 1,001,926
228	1.33	75 %	$ 247,420.88	$ 1,403,433	$ 1,062,557
240	1.28	77 %	$ 258,943.40	$ 1,479,938	$ 1,123,188
252	1.26	79 %	$ 270,465.92	$ 1,552,292	$ 1,179,667
264	1.22	81 %	$ 281,988.44	$ 1,628,798	$ 1,240,298
276	1.19	84 %	$ 293,510.96	$ 1,705,303	$ 1,300,928
288	1.16	86 %	$ 305,033.48	$ 1,781,809	$ 1,361,559
300	1.13	88 %	$ 316,556.00	$ 1,858,315	$ 1,422,190
312	1.01	89 %	$ 328,078.52	$ 1,965,668	$ 1,513,669

Table B-2 Scenario Two Results

Annual Student Throughput Rate	Pay-Back Period (in years)	Rate-Of-Return (first year)	Annual Cost Avoidance	Total Savings (7 years)	NPV Of Total Savings (5.8 %)
36	2.28	43 %	$ 109,515.32	$ 516,982	$ 366,101
48	2.10	47 %	$ 121,037.84	$ 593,487	$ 426,732
60	1.95	51 %	$ 132,560.36	$ 669,993	$ 487,363
72	1.85	54 %	$ 144,082.88	$ 742,347	$ 543,841
84	1.74	57 %	$ 155,605.40	$ 818,852	$ 604,472
96	1.64	60 %	$ 167,127.92	$ 895,358	$ 665,103
108	1.56	64 %	$ 178,650.44	$ 971,864	$ 725,734
120	1.49	67 %	$ 190,172.96	$ 1,048,369	$ 786,365
132	1.44	69 %	$ 201,695.48	$ 1,120,723	$ 842,844
144	1.38	72 %	$ 213,218.00	$ 1,197,229	$ 903,475
156	1.33	75 %	$ 224,740.52	$ 1,273,734	$ 964,106
168	1.29	77 %	$ 236,263.04	$ 1,350,240	$ 1,024,736
180	1.24	80 %	$ 247,785.56	$ 1,426,746	$ 1,085,367
192	1.22	82 %	$ 259,308.08	$ 1,499,099	$ 1,141,846
204	1.18	84 %	$ 270,830.60	$ 1,575,605	$ 1,202,477
216	0.97	101 %	$ 329,846.12	$ 1,984,561	$ 1,530,127
228	0.94	103 %	$ 341,368.64	$ 2,061,067	$ 1,590,758
240	0.91	106 %	$ 352,891.16	$ 2,137,573	$ 1,651,389
252	0.90	106 %	$ 364,413.68	$ 2,209,926	$ 1,707,868
264	0.88	108 %	$ 375,936.20	$ 2,286,432	$ 1,768,498
276	0.86	110 %	$ 387,458.72	$ 2,362,938	$ 1,829,129
288	0.84	112 %	$ 398,981.24	$ 2,439,443	$ 1,889,760
300	0.82	114 %	$ 410,503.76	$ 2,515,949	$ 1,950,391
312	0.70	115 %	$ 422,026.28	$ 2,623,303	$ 2,041,870

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APPENDIX C

SENSITIVITY ANALYSIS GRAPHS

Two Capital Expenditure Analysis data points, Pay-back Period and Total Savings, are used by the R&DC analysts to delineate between operation of the ILRES course, and operation of the NRCBT version of the same course. Since values of both cost and non-cost factors considered in a Cost Model run are used to generate the Pay-back Period and Total Savings, a sensitivity analysis was performed for many of those factors. The purpose of the sensitivity analysis was to explore the sensitivity of Pay-back Period and Total Savings to changes in the values of the chosen factors. Table C-1 lists the factors for which a sensitivity analysis was performed, and identifies the corresponding set of figures (graphs) which display the results. The results of the sensitivity analysis are discussed in section "Cost Model Runs And Analysis Of Results" of the main body of this report. Appendix C presents a set of graphs for each sensitivity analysis performed. The graphs show the results of the sensitivity analysis, across the complete range of changes considered. A 100 percent change designates the base value (e.g., Training Center Operations & Personnel base value is $150,206). Base values for all cost factors are presented in Tables 3-5 and 3-6, which appear in the main body of this report.

In reviewing the various graphs, the reader may notice significant increases in dollar values or an unusual change in Pay-back Period between Annual Student Throughput Rates of 204 and 216 students, and again, between 300 and 312 students. Above 204 students per year, an additional instructor is required for the ILRES course based on data input to the Cost Model. Above 300 students per year, an additional AN/WSC-3(v)7 UHF transceiver is required for the ILRES course based on data input to the Cost Model.

Table C-1 List of Factors Explored in Sensitivity Analysis

FACTOR TYPE/FACTOR NAME	FIGURE
GENERIC FACTORS	
Annual Student Throughput Rate (Comparing Difference In Sensitivity For Both Scenarios One And Two)	C-1
Course Life-span	C-2
ILRES COST FACTORS	
Training Center Operations & Personnel	
Comparison Of Treatments (O&M Cost vs. Per Student Cost)	C-3
Treated As O&M Cost	C-4
Student Transportation	C-5
Student Materials	C-6
NRCBT COST FACTORS	
CBT Design & Development	C-7
USCG Subject Mater Expert Support	C-8
Equipment for Course Distribution	C-9
Courseware Maintenance	C-10
Student Support	C-11
Distribution Center Operations & Personnel	C-12
Duty Station Facilitator Time	C-13
Shipping of Course Materials	C-14
Student Time	C-15
Student Materials	C-16

FACTOR TYPE : Generic Factor (Non-cost)
FACTOR NAME : Annual Student Throughput Rate
(Comparing Difference In Sensitivity For Scenarios One & Two)

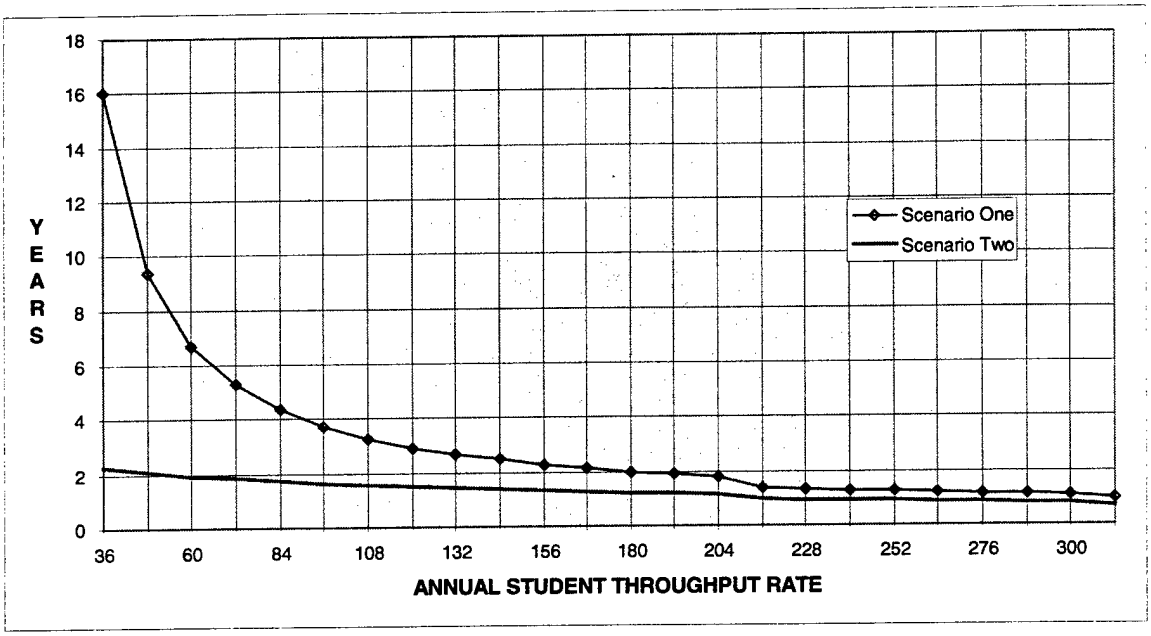

Figure C-1(a) Pay-back Period for Changes in Annual Student Throughput Rate

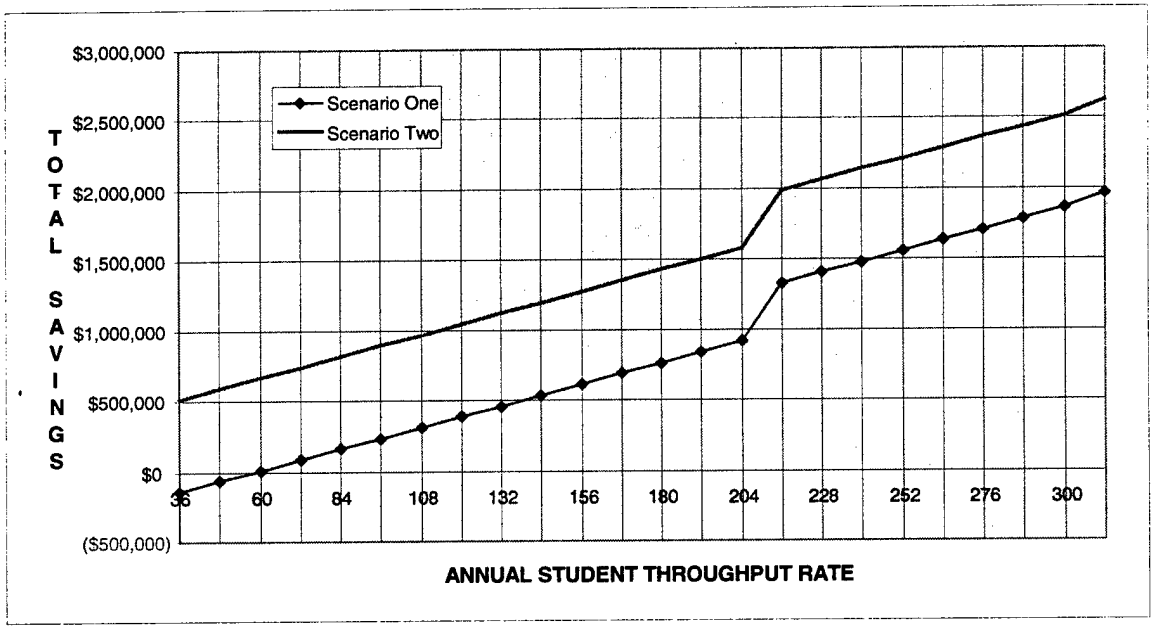

Figure C-1(b) Total Savings for Changes in Annual Student Throughput Rate

FACTOR TYPE : Generic Factor (Non-cost)
FACTOR NAME : Course Life-span
(Scenario Two)

No figure for Pay-back Period is presented. Pay-back Period of 1.85 years for Scenario Two does not change as the result of percentage changes in the life-span of the course.

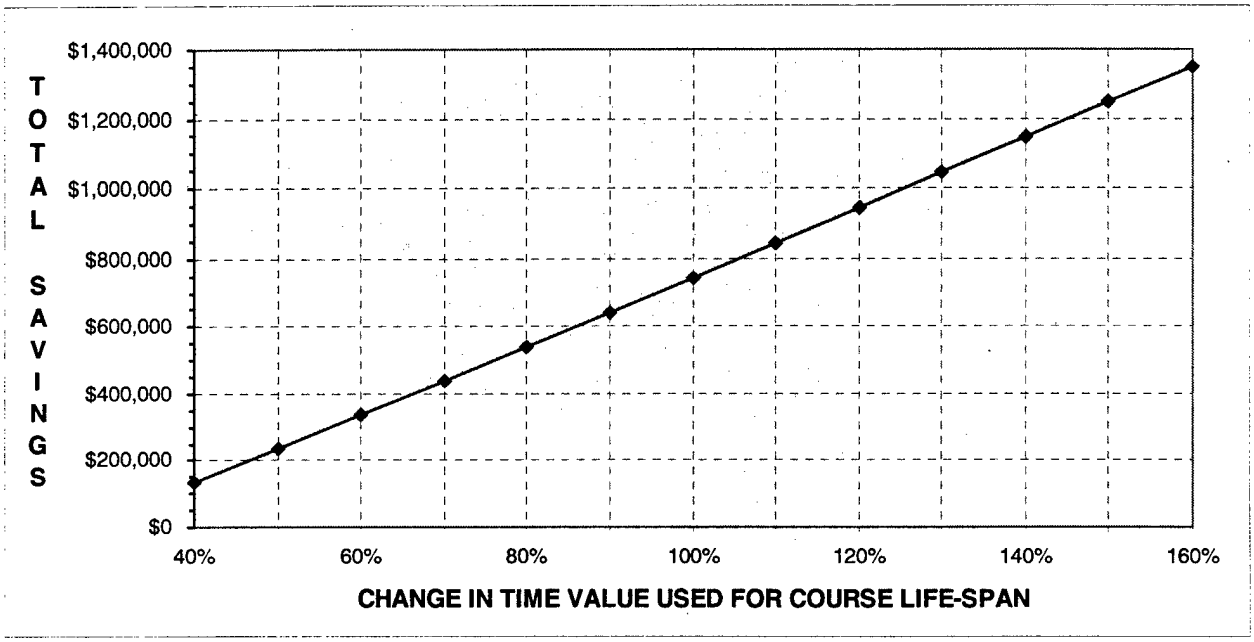

Figure C-2 Total Savings for Changes in Course Life-span (Time)

FACTOR TYPE : ILRES Cost Factor

FACTOR NAME : Training Center Operations & Personnel
(Comparing Treatment As O&M Cost, And Per Student Cost)
(Scenario Two)

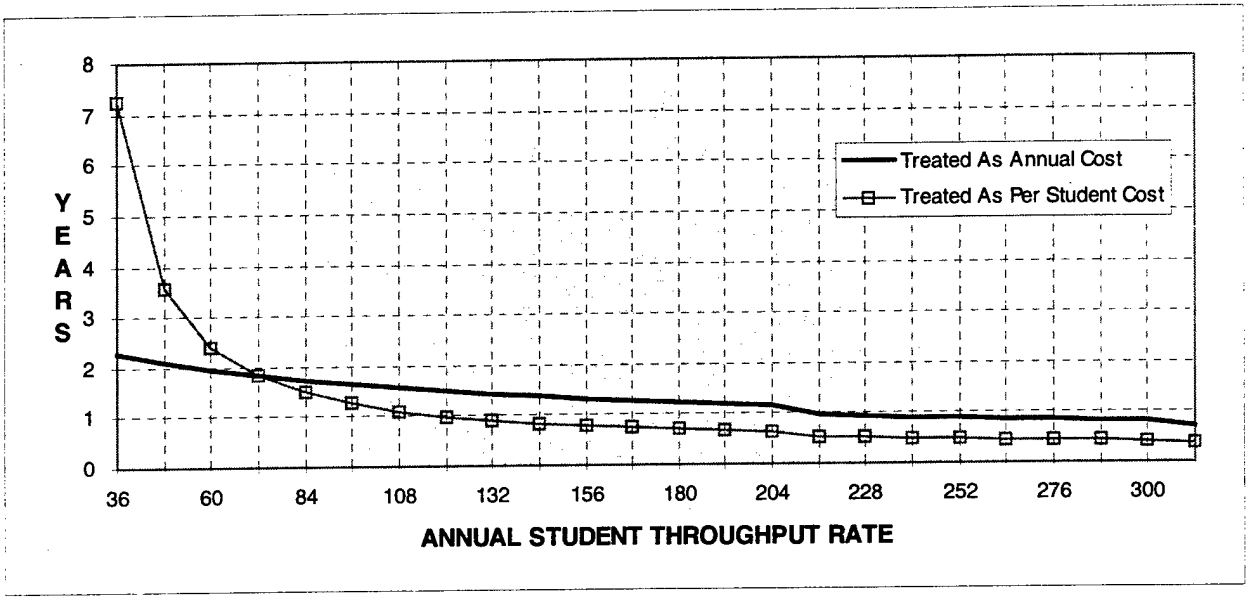

Figure C-3(a) Pay-back Period for Comparing Treatment of Training Center Operations & Personnel (O&M Cost VS. Per Student Cost)

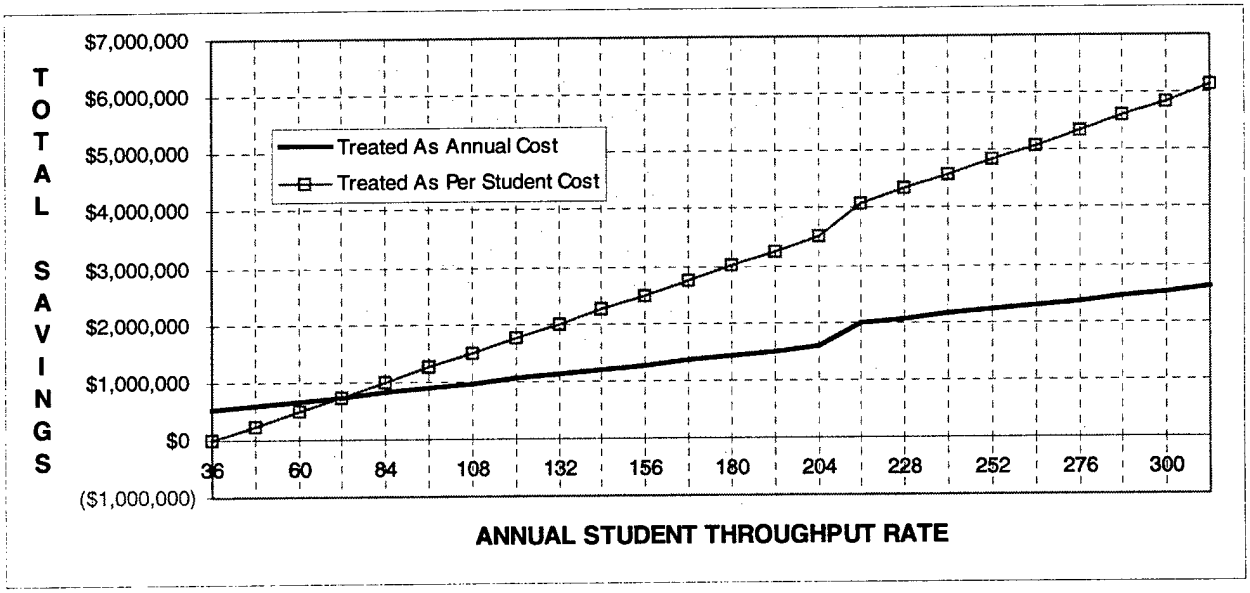

Figure C-3(b) Total Savings for Comparing Treatment of Training Center Operations & Personnel (O&M Cost VS. Per Student Cost)

FACTOR TYPE : ILRES Cost Factor

FACTOR NAME : Training Center Operations & Personnel
(Scenario Two - Treated As O&M Cost)

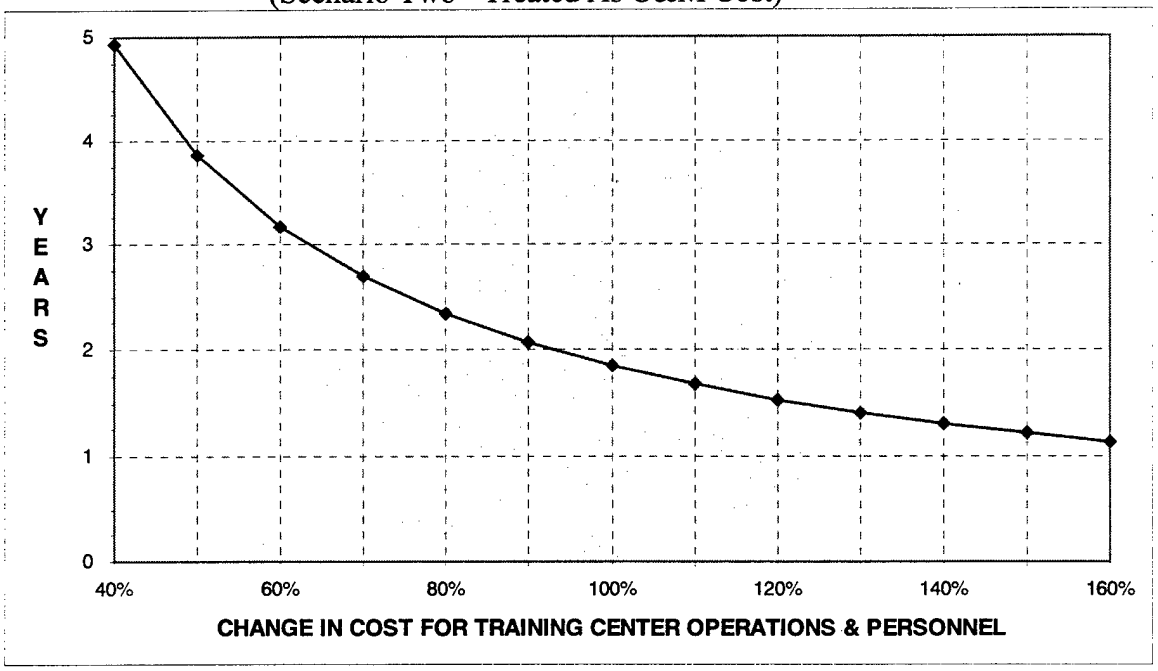

Figure C-4(a) Pay-back Period for Changes in Cost of Training Center Operations & Personnel

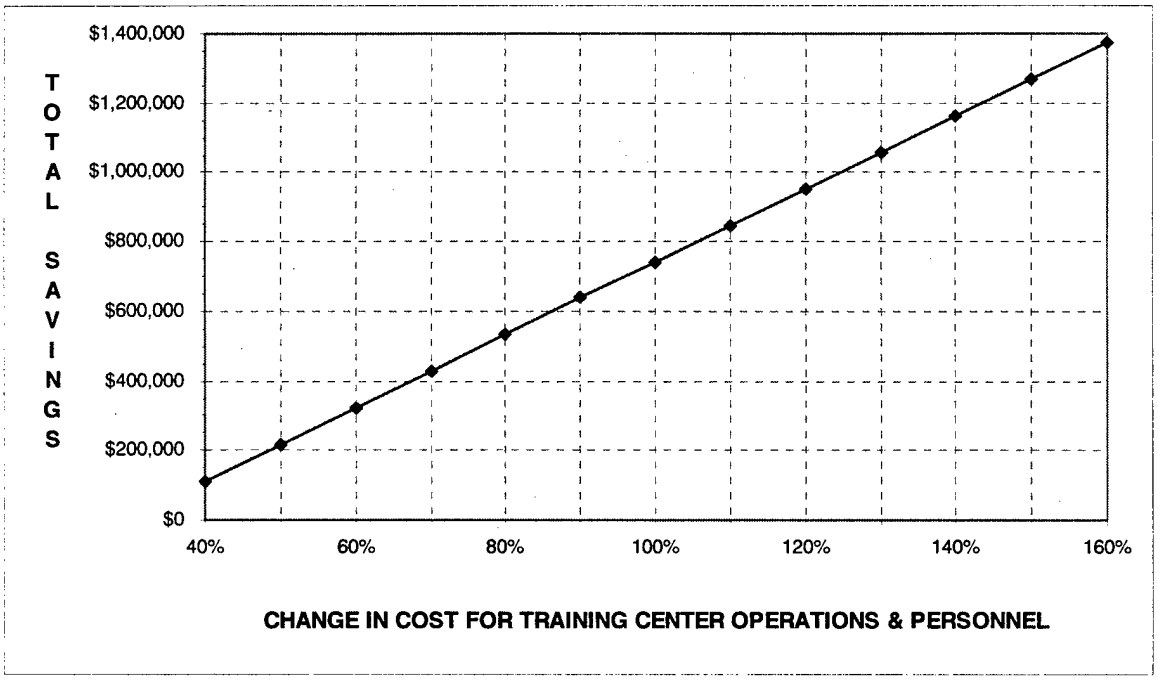

Figure-C-4(b) Total Savings for Changes in Cost of Training Center Operations & Personnel

FACTOR TYPE : ILRES Cost Factor

FACTOR NAME : Student Transportation
(Scenario Two)

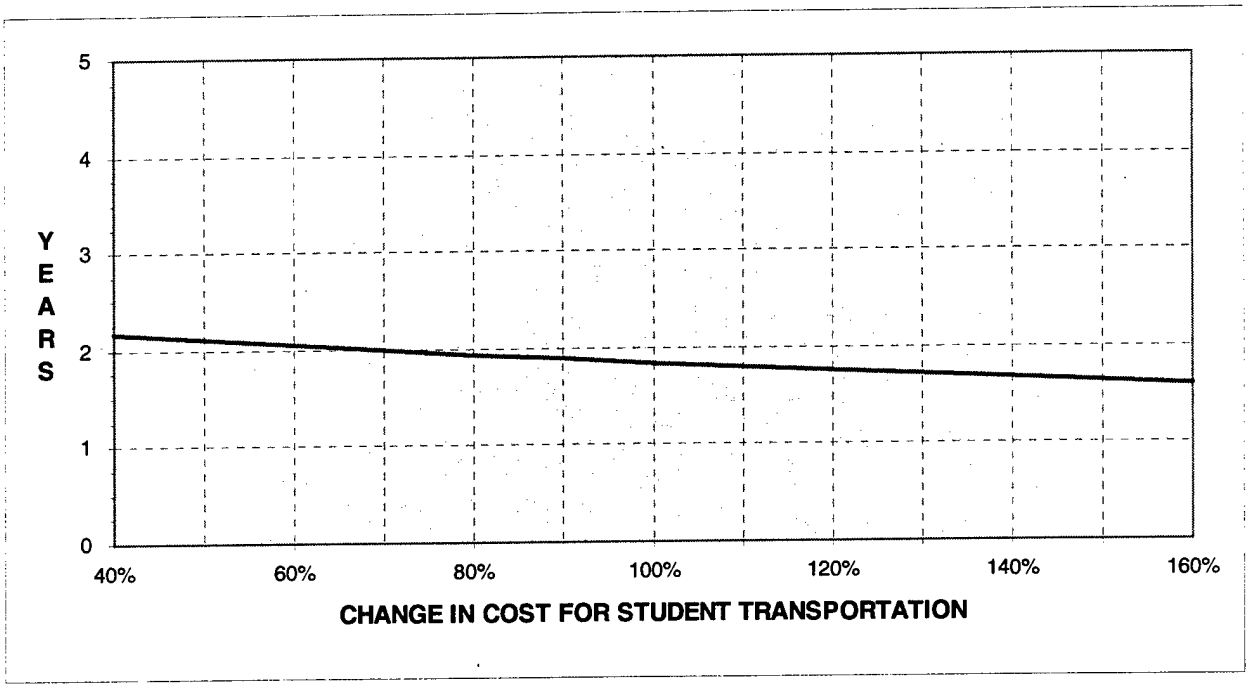

Figure C-5(a) Pay-back Period for Changes in Cost of Student Transportation

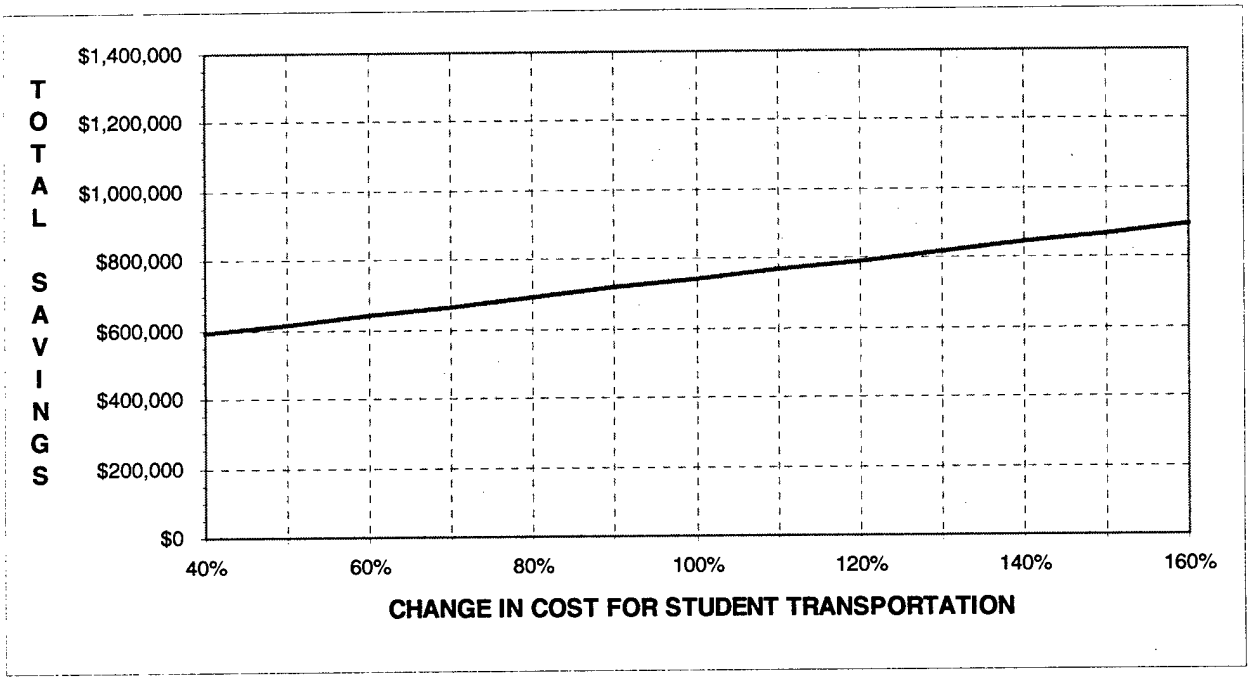

Figure C-5(b) Total Savings for Changes in Cost of Student Transportation

FACTOR TYPE : ILRES Cost Factor
FACTOR NAME : Student Materials
(Scenario Two)

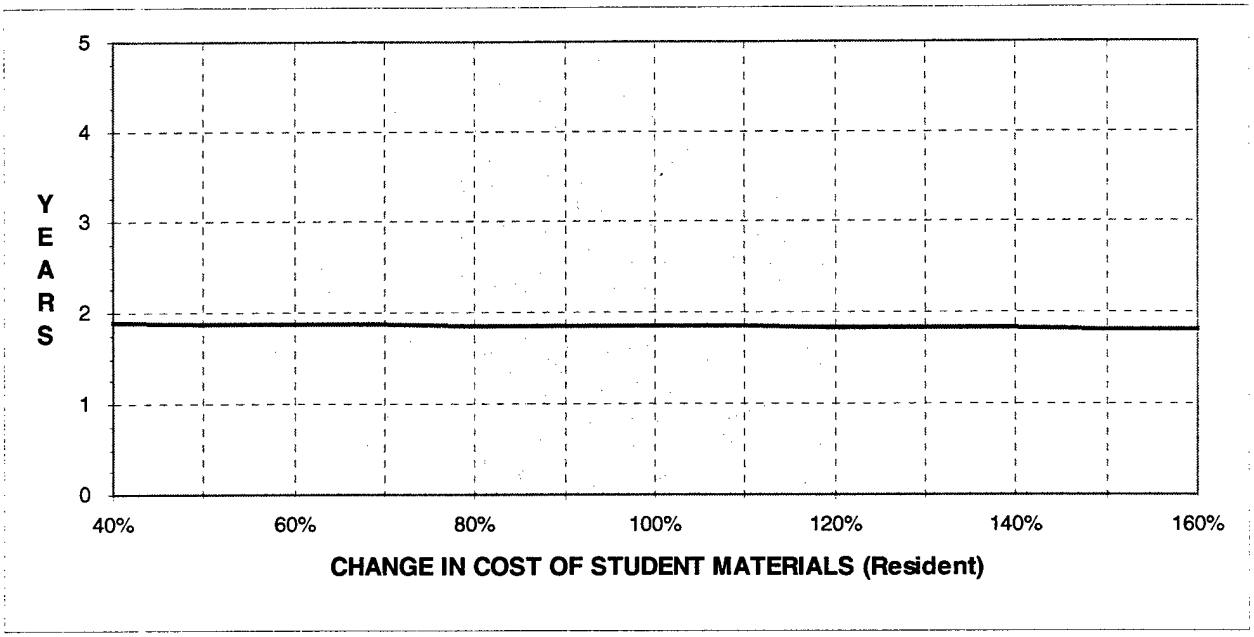

Figure C-6(a) Pay-back Period for Changes in Cost of Student Materials (ILRES)

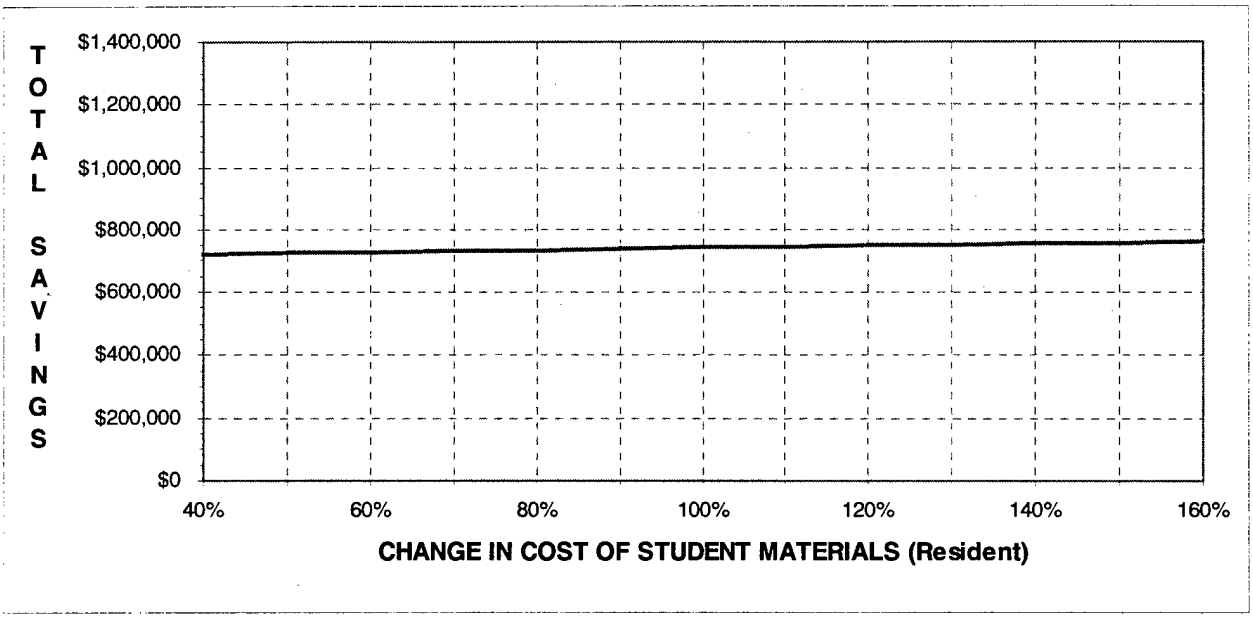

Figure C-6(b) Total Savings for Changes in Cost of Student Materials (ILRES)

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : CBT Design & Development
(Scenario Two)

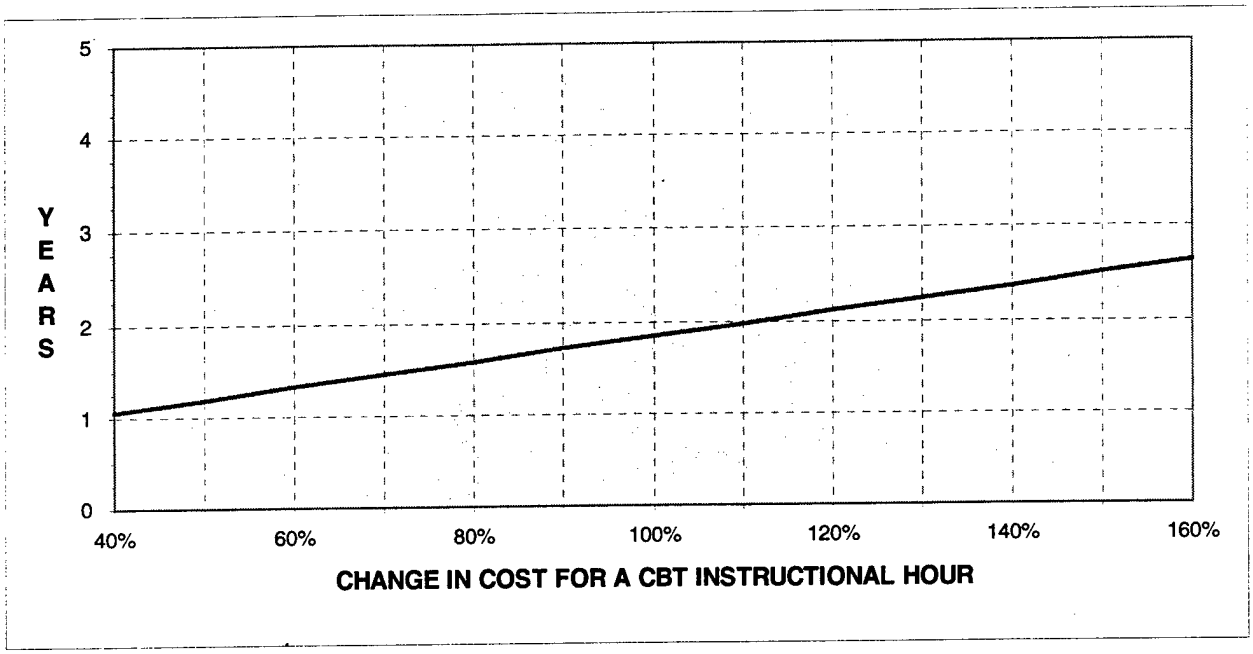

Figure C-7(a) Pay-back Period for Changes in Cost Per CBT Instructional Hour, a Parameter of the CBT Design & Development Cost Factor

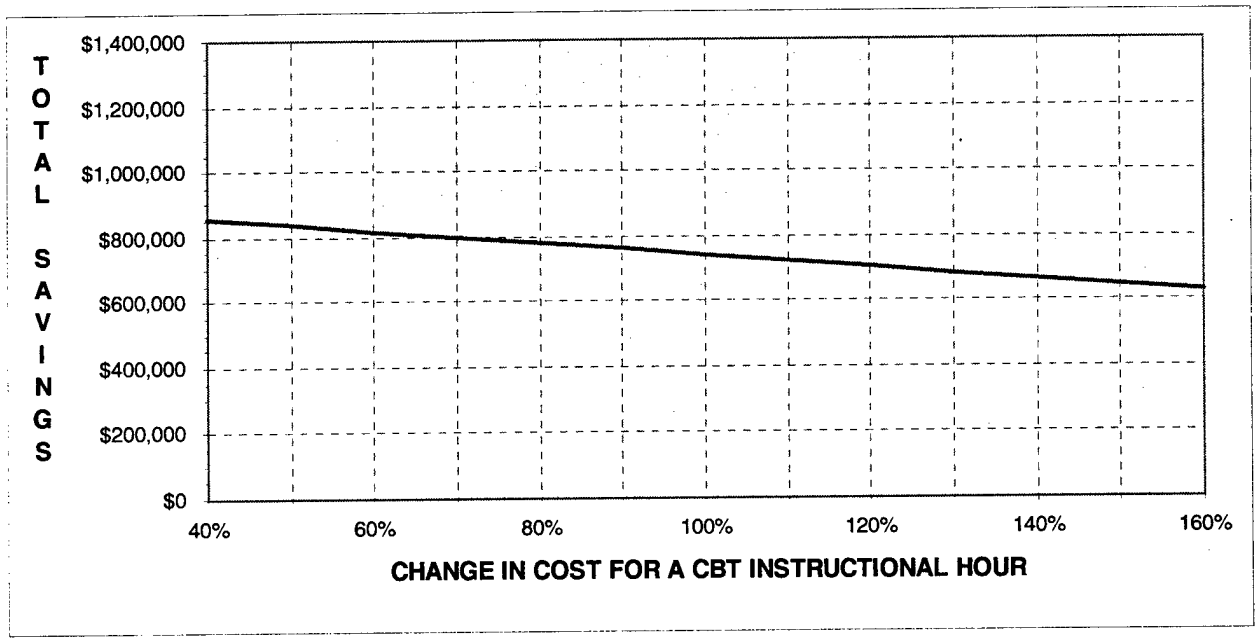

Figure C-7(b) Total Savings for Changes in Cost Per CBT Instructional Hour, a Parameter of the CBT Design & Development Cost Factor

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : USCG Subject Matter Expert Support
(Scenario Two)

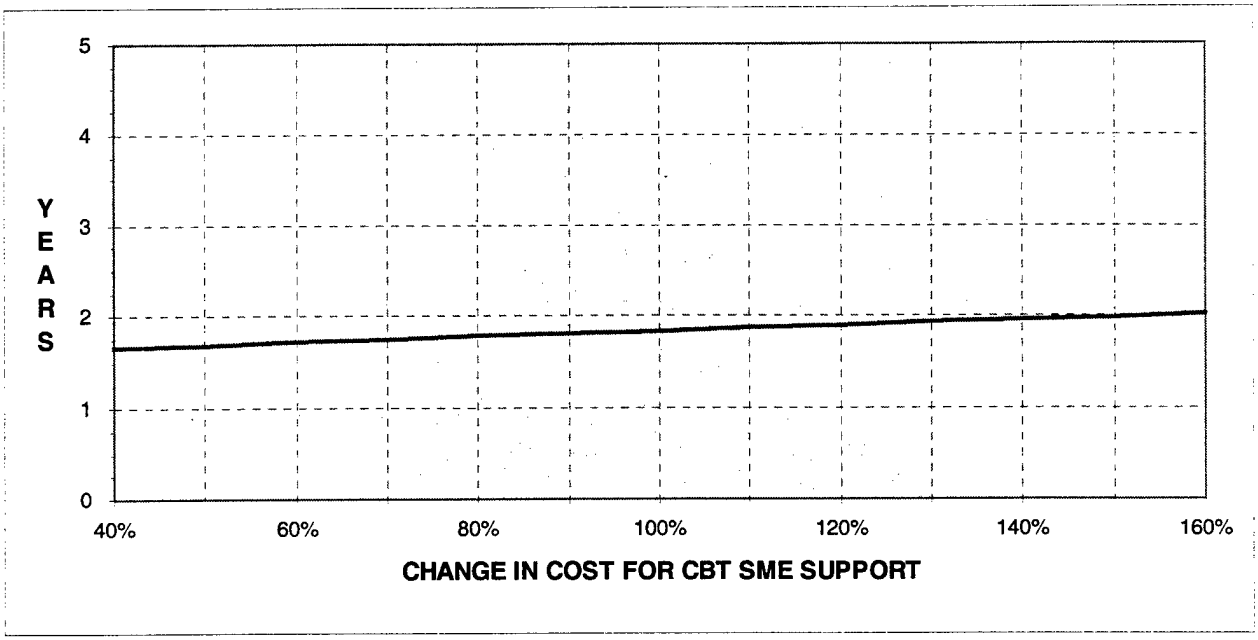

Figure C-8(a) Pay-back Period for Changes in Cost of USCG Subject Matter Expert Support

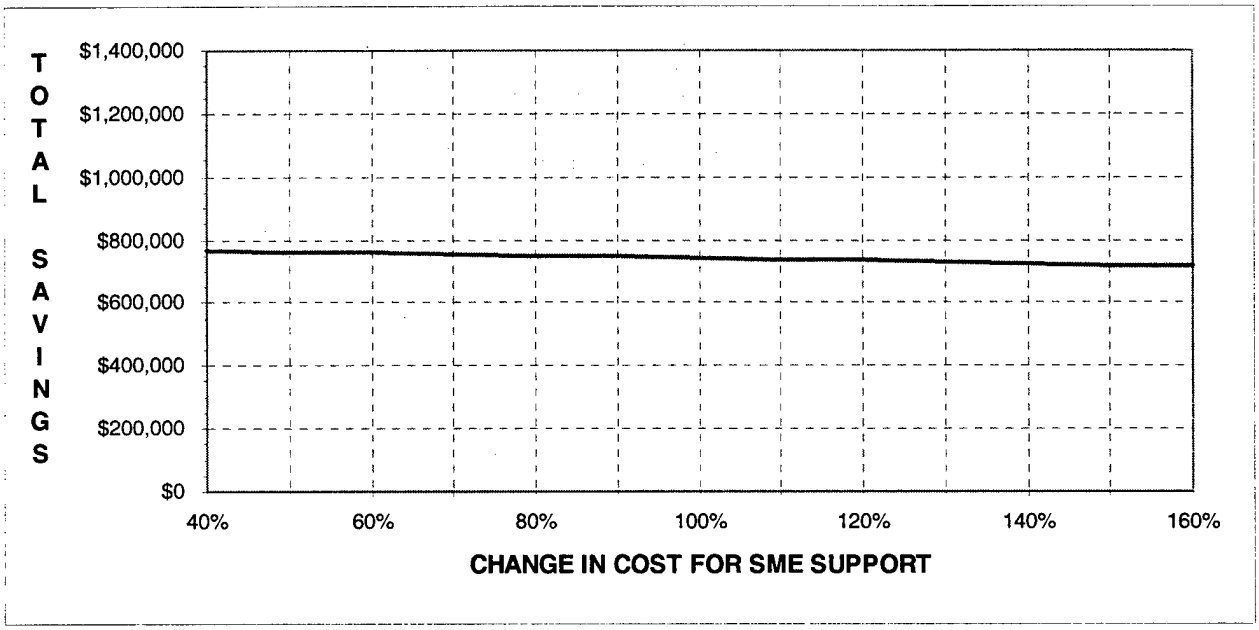

Figure C-8(b) Total Savings for Changes in Cost of USCG Subject Matter Expert Support

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Equipment for Course Distribution
(Scenario Two)

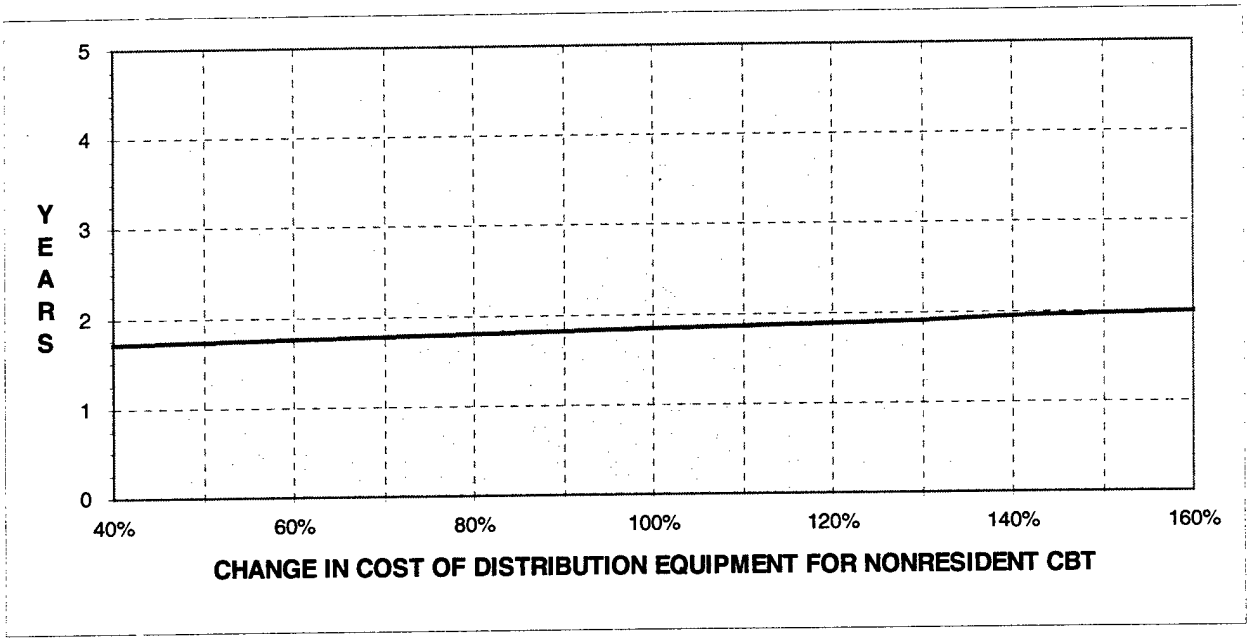

Figure C-9(a) Pay-back Period for Changes in Cost of Equipment for Course Distribution

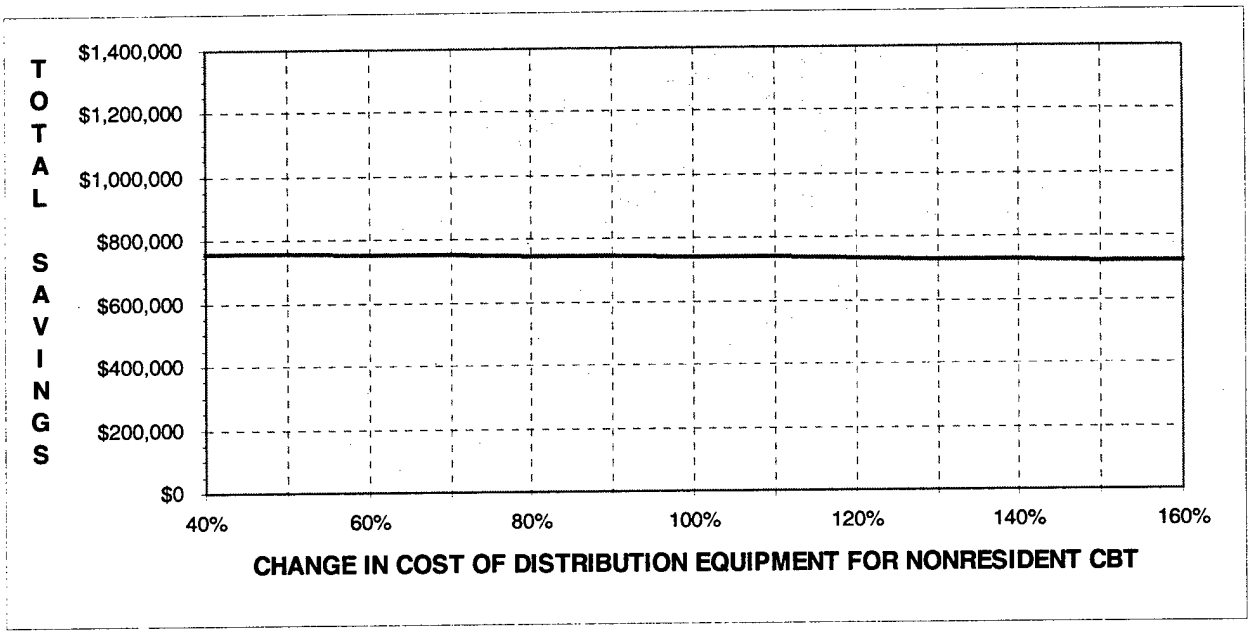

Figure C-9(b) Total Savings for Changes in Cost of Equipment for Course Distribution

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Courseware Maintenance
(Scenario Two)

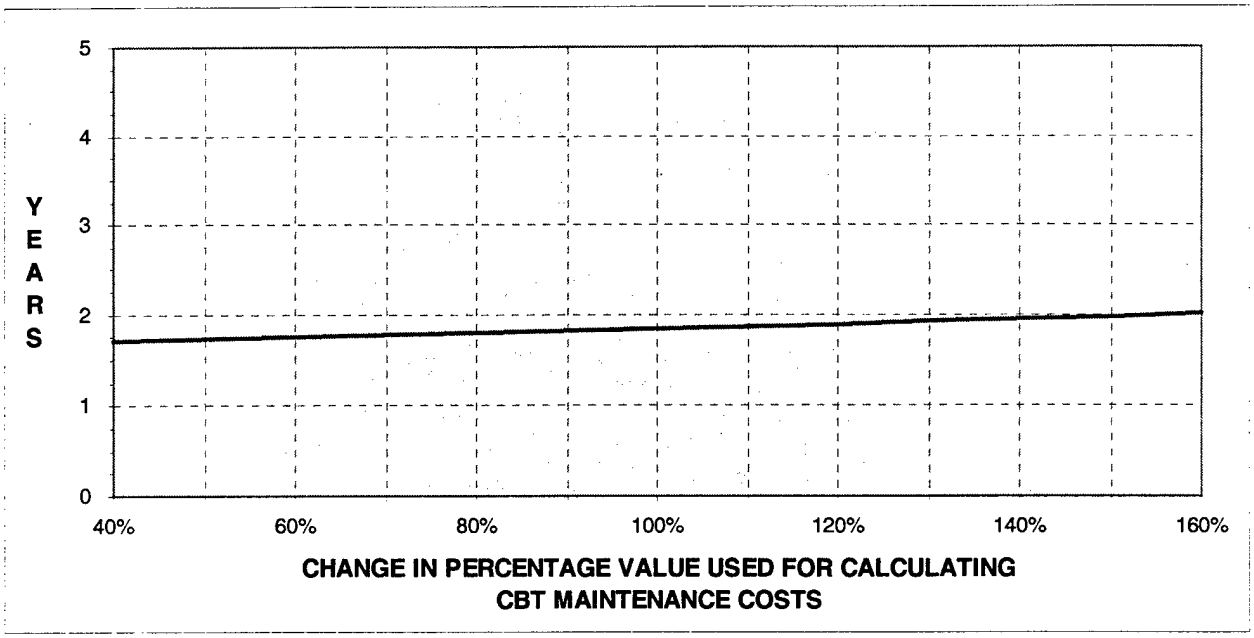

Figure C-10(a) Pay-back Period for Changes in Percentage Value Used for Courseware Maintenance

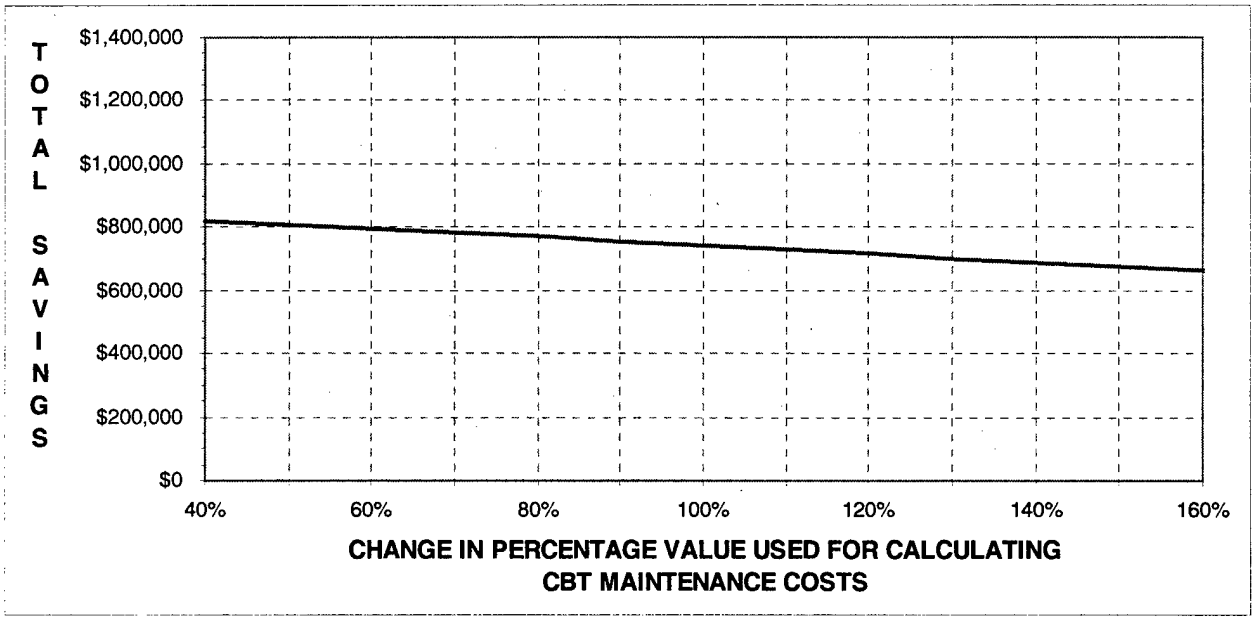

Figure C-10(b) Total Savings for Changes in Percentage Value Used for Courseware Maintenance

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Student Support
(Scenario Two)

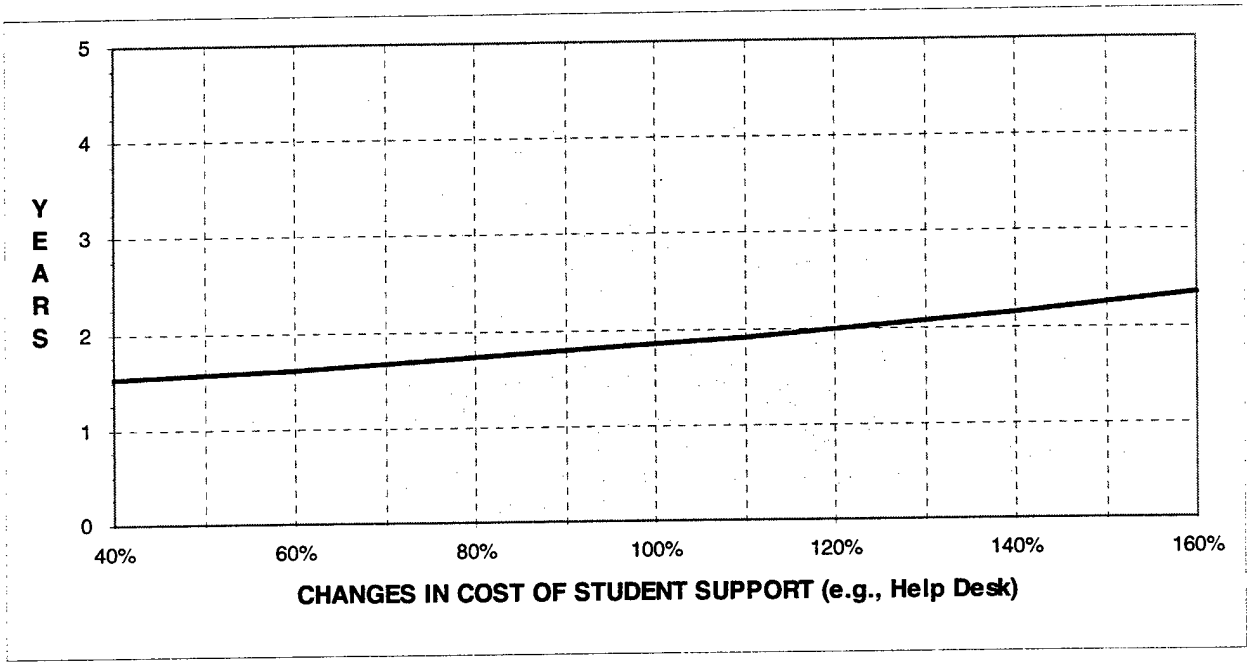

Figure C-11(a) Pay-back Period for Changes in Costs of Student Support

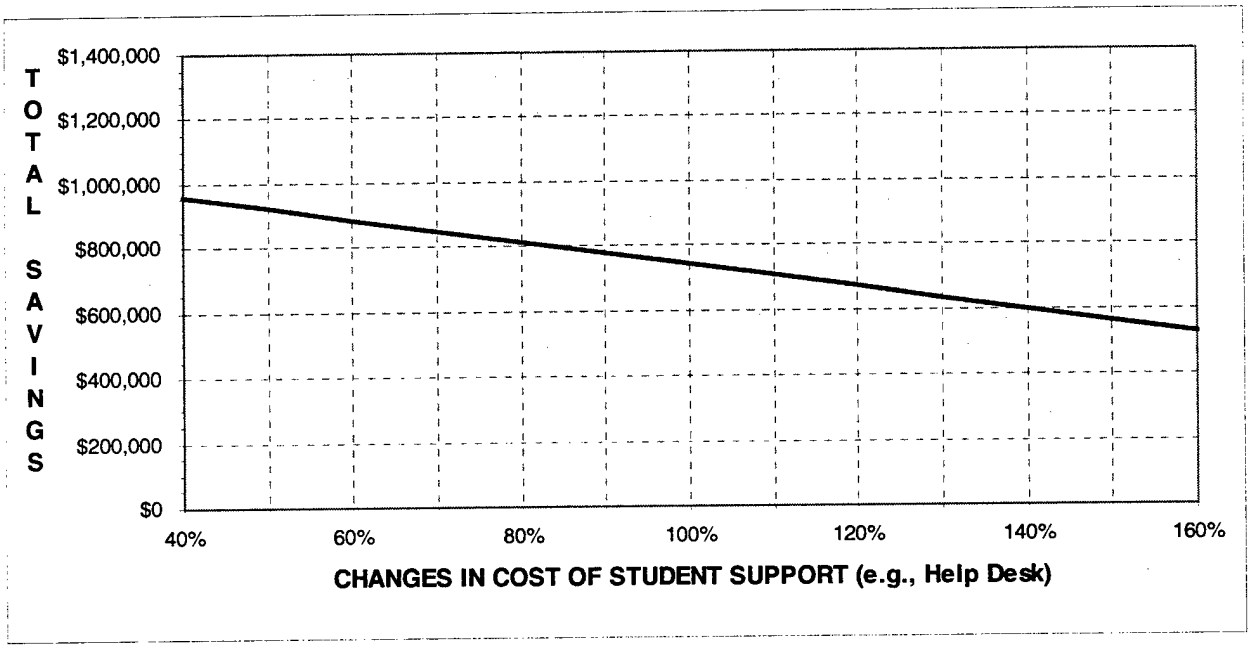

Figure C-11(b) Total Savings for Changes in Costs of Student Support

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Distribution Center Operations & Personnel (Scenario Two)

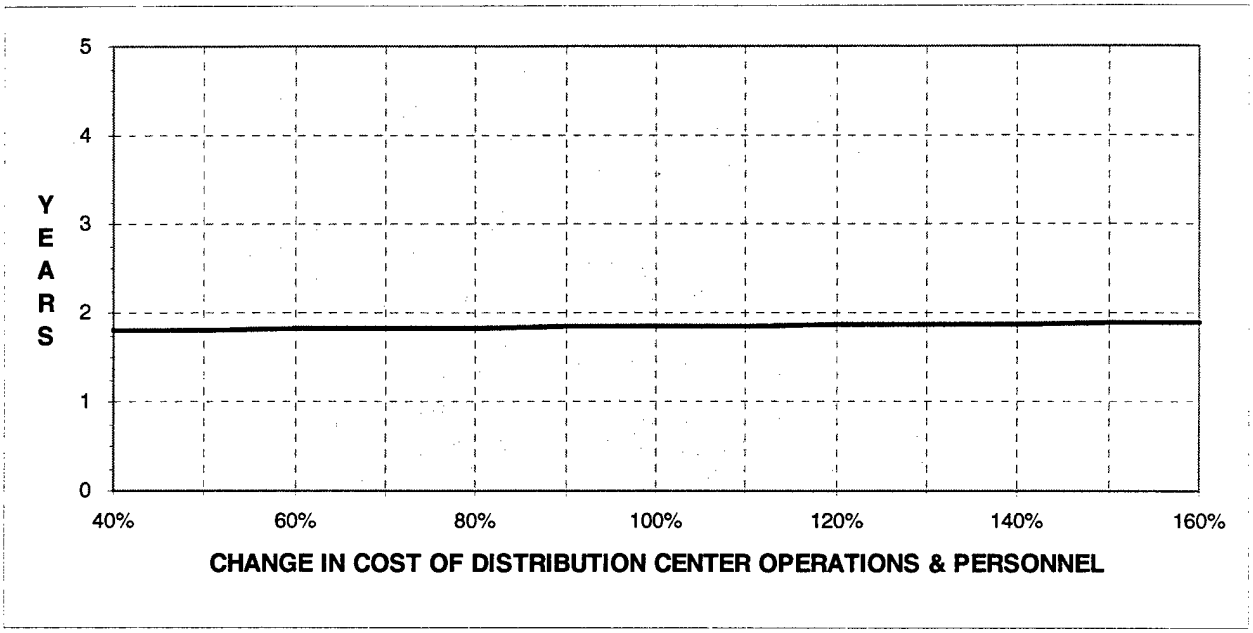

Figure C-12(a) Pay-back Period for Cost Changes to Distribution Center Operations & Personnel

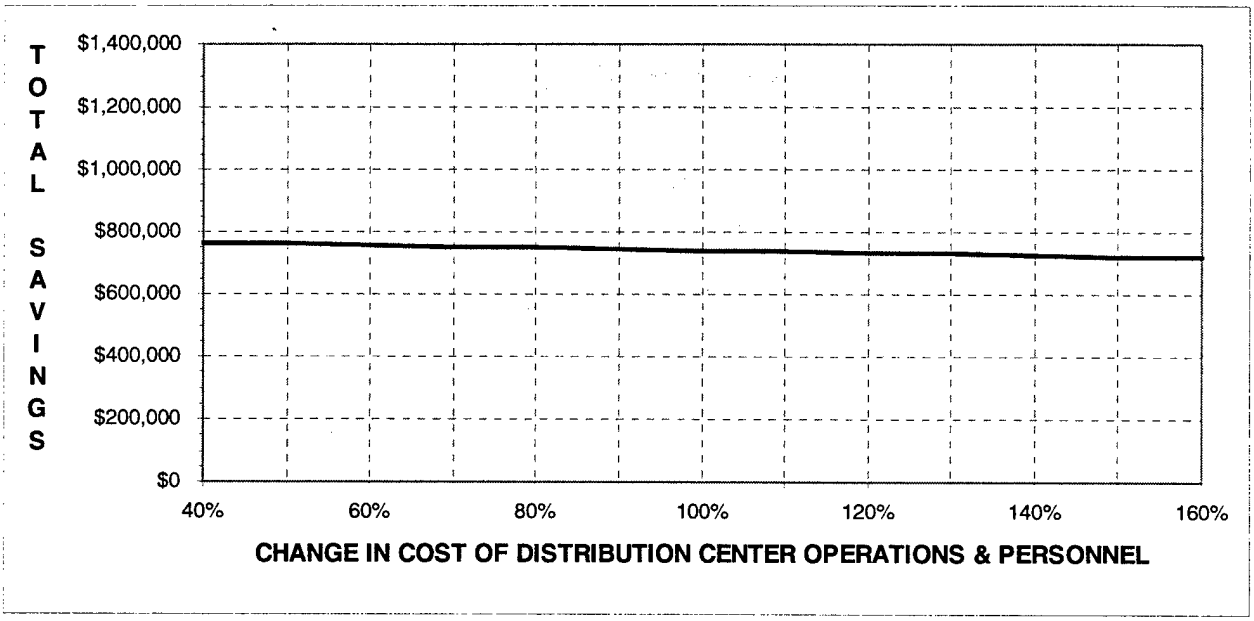

Figure C-12(b) Total Savings for Cost Changes to Distribution Center Operations & Personnel

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Duty Station Facilitator Time
(Scenario Two)

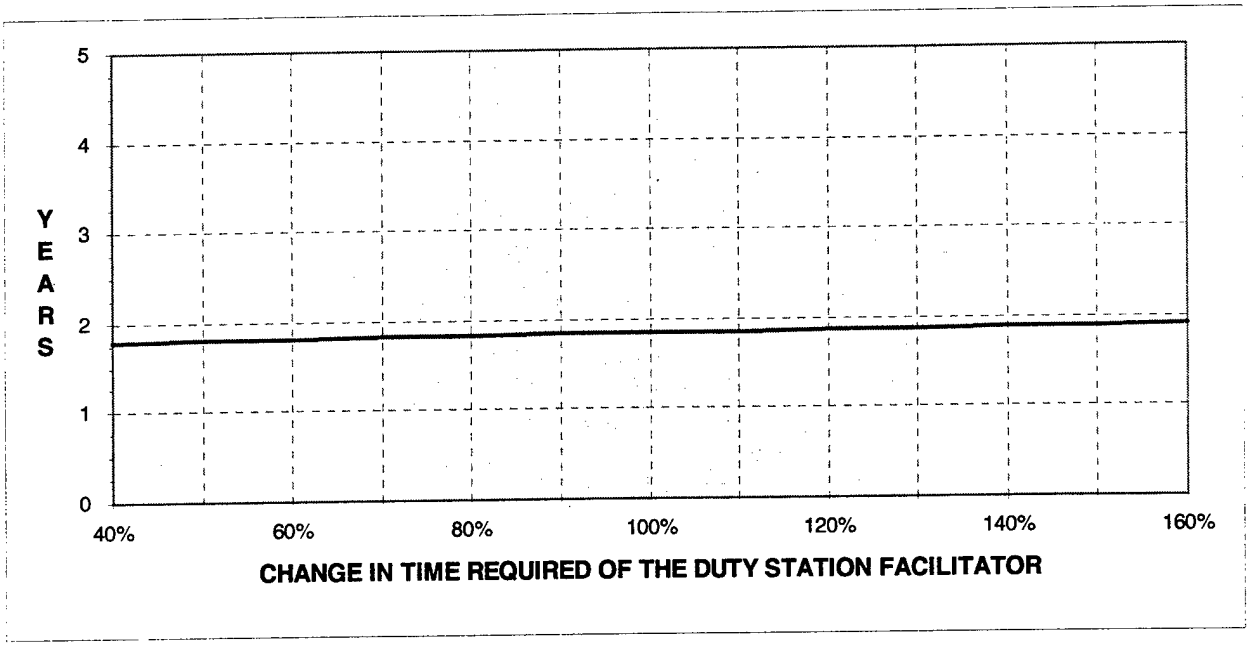

Figure C-13(a) Pay-back Period for Changes in Facilitation Time of Facilitator

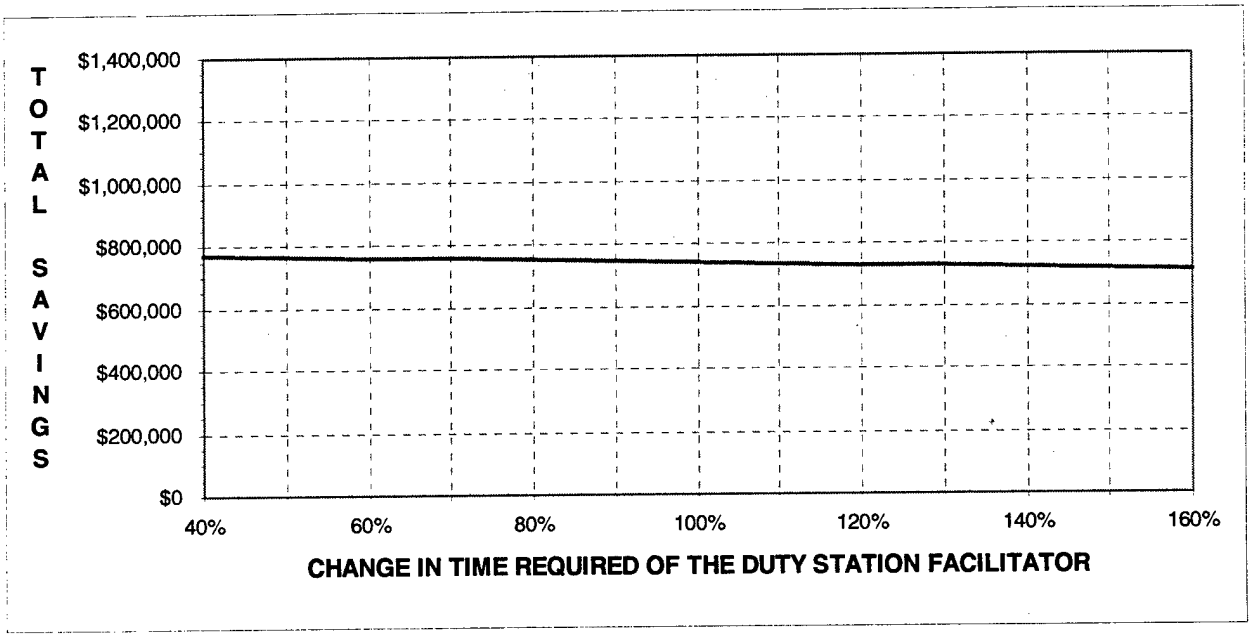

Figure C-13(b) Total Savings for Changes in Facilitation Time of Facilitator

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Shipping Of Course Materials
(Scenario Two)

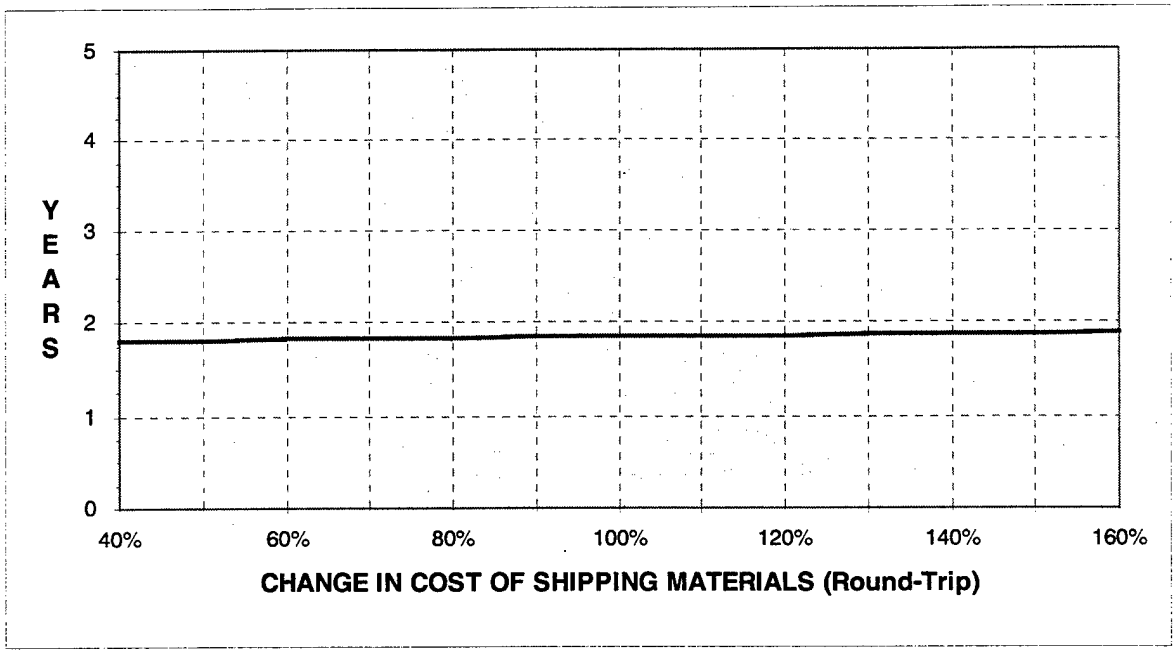

Figure C-14(a) Pay-back Period for Changes in Costs to Ship Course Materials

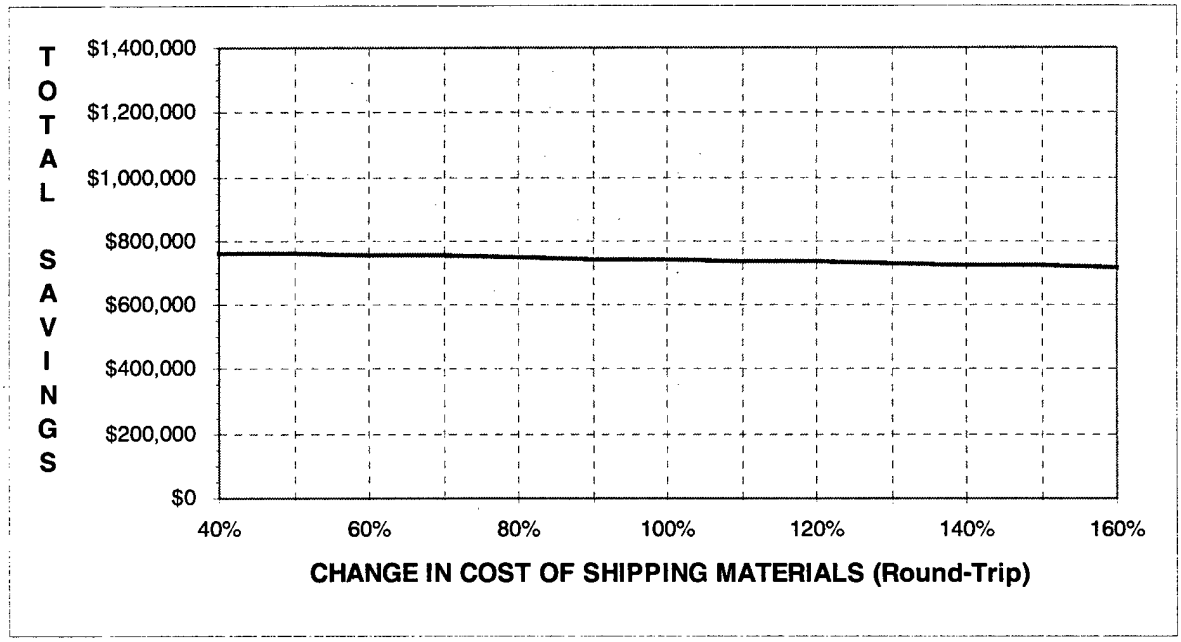

Figure C-14(b) Total Savings for Changes in Costs to Ship Course Materials

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Student Time
(Scenario Two)

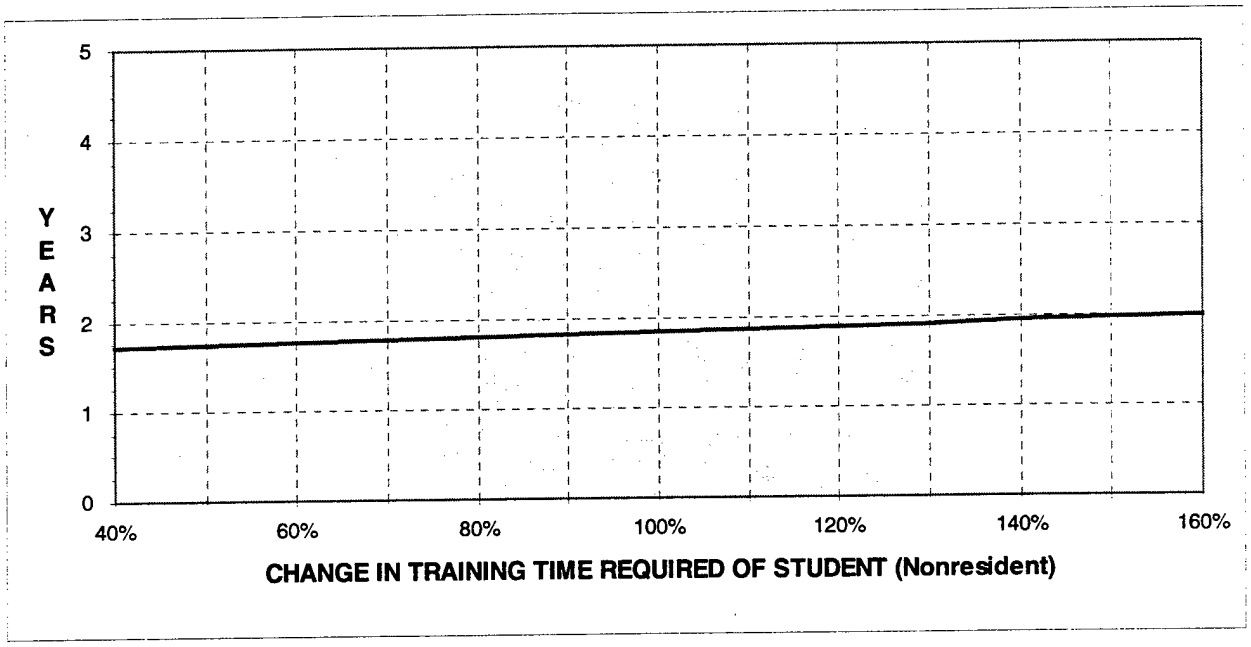

Figure C-15(a) Pay-back Period for Changes in Training Time of Student (NRCBT)

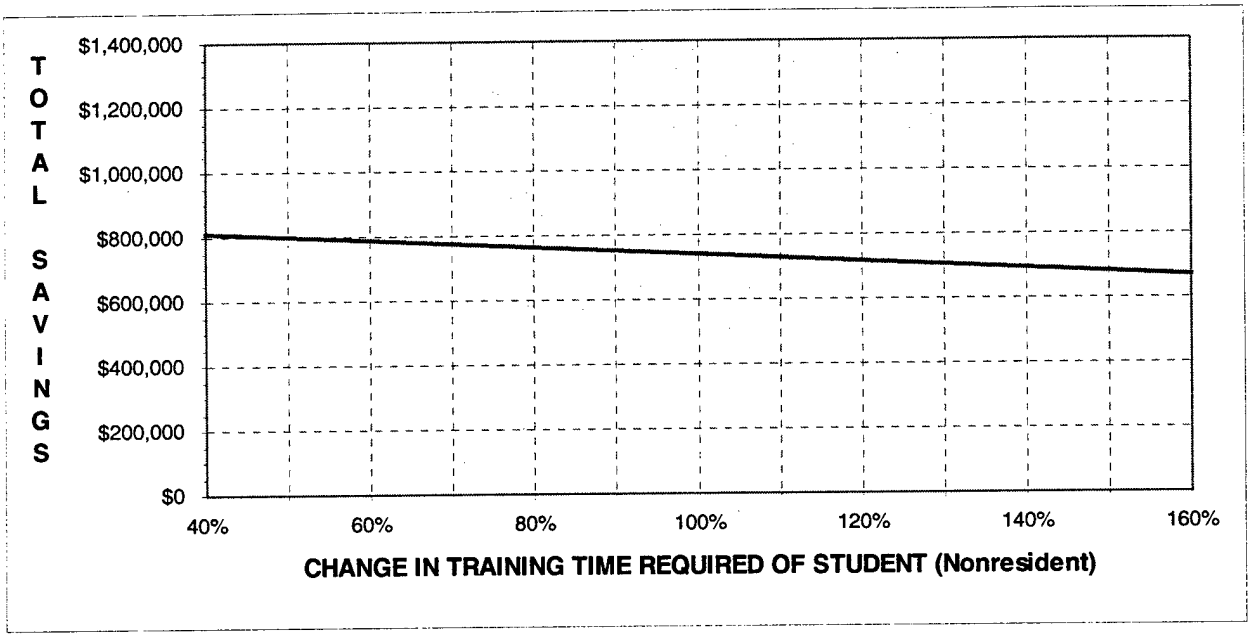

Figure C-15(b) Total Savings for Changes in Training Time of Student (NRCBT)

FACTOR TYPE : NRCBT Cost Factor
FACTOR NAME : Student Materials
(Scenario Two)

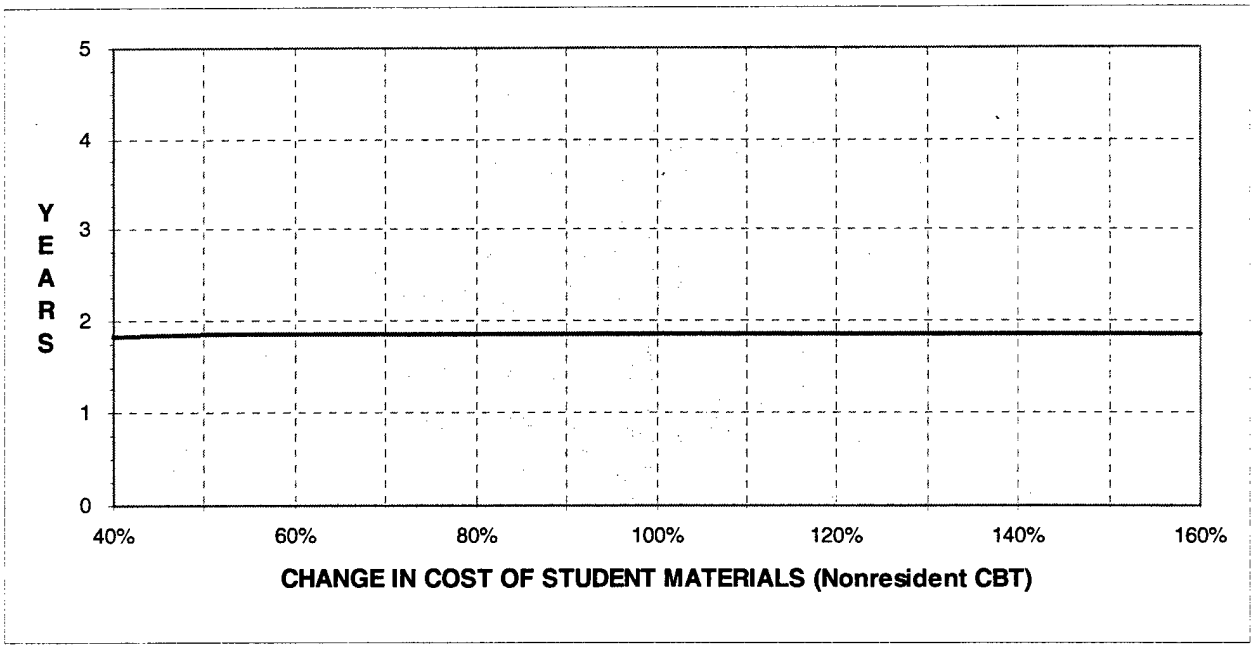

Figure C-16(a) Pay-back Period for Changes in Costs of Student Materials (NRCBT)

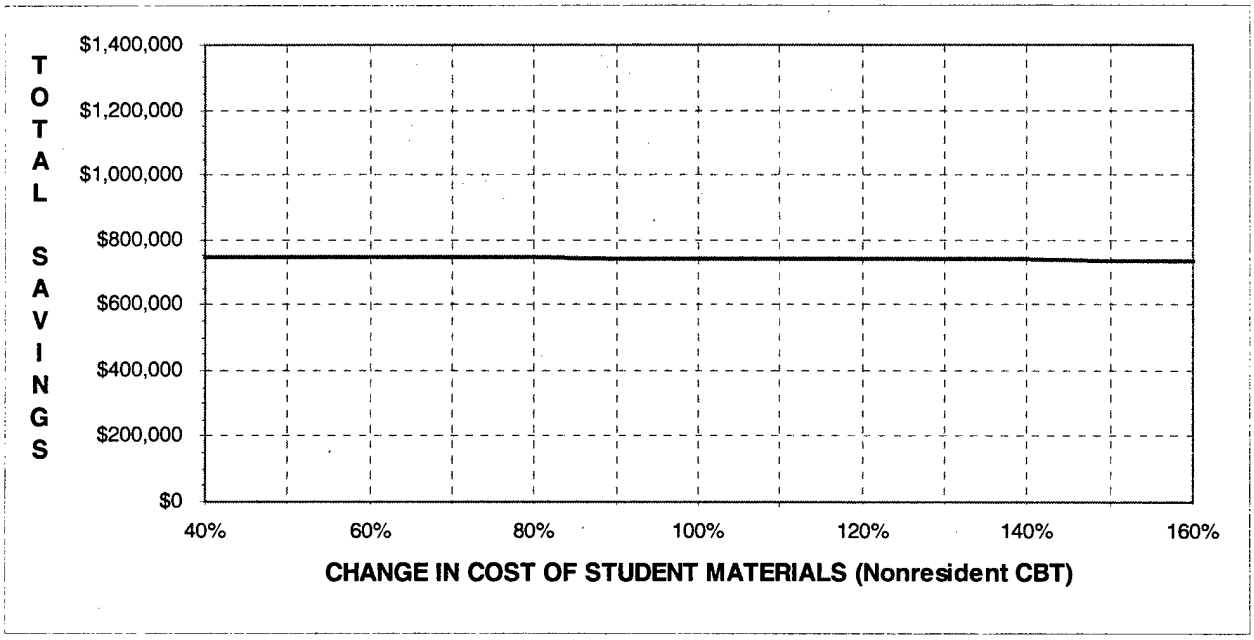

Figure C-16(b) Total Savings for Changes in Costs of Student Materials (NRCBT)